THE GLASS INDUSTRY

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ALUMINATE GLASSES

By KUAN-HAN SUN

Aluminum is one of the most important minor components in commercial glasses. As a major component, it can also be introduced in large amount in silicate, borate, phosphate types of glass and particularly in pure aluminate glass. Although the aluminate glass has been known for some time, particularly to investigators in the study of phase systems of various combination of oxides,[1] little is known regarding the nature and behavior of this type of glass except for the knowledge of liquidus temperature. A few years ago, the writer in the search of new optical glasses made a number of aluminate glasses with varying composition. Recently Lindroth and Tooley reported on the glass formation in the well-known system, $CaO\text{-}Al_2O_3$.[2]

Aluminate glass may be defined as a glass in which the main or the sole glass former is the component, aluminum oxide. A pure aluminate glass should contain no other glass formers, such as SiO_2, $BO_{1.5}$(or B_2O_3), $PO_{2.5}$(P_2O_5), GeO_2, and others. To glass students, the aluminum oxide is generally known as the intermediate which does not form a glass in its pure form under ordinary conditions, but forms a glass when it is combined with suitable modifiers.

The fact that boron assumes two roles in glass is well-known to workers and students in glass technology and science. One kind of boron is surrounded by three immediate oxygen neighbors and is said to have 3-fold coordination, the other by four oxygen neighbors and is called 4-fold coordination. For simplicity we shall designate them as B(3) and B(4), respectively. A similar notation will be adopted for aluminum or other elements which assume two or more coordination states. These two kinds of boron mentioned above behave entirely different in their contribution to glass properties and may as well be, or rather should be treated as two independent and different components. For an example, the presence of B(4) increases the refractive index, the Abbe value and the basicity of a borate glass, and lowers its coefficient of expansion.

It is an established fact that in crystalline compounds there are two kinds of aluminum, namely, Al(4) and Al(6)[3]. Aluminum oxide (corundum), for example, has all its aluminum atoms surrounded by six oxygens while in many aluminosilicates, the well-known substitution of CaAl for NaSi occurs and aluminum atoms are surrounded by four oxygen atoms. These two kinds of aluminums act like two different entities in contributing physical properties to crystals. Their Al-O binding strength and interatomic distance, for instance, are different, and so are other properties.

Evidences of the existence of these two kinds of aluminum atoms in glass are known. For example, Safford and Silverman[4] have noted the deviation from the linear relationship in "molecular refractions" when high aluminum-containing soda-lime-silicate glasses were studied. In the investigation of the relationship between properties and composition of glass, the writer has often found it inadequate to assign a single and constant factor for the component aluminum oxide in the composition ranges where other components assume a constant factor for the property contribution. In general, aluminum would assume a six-fold coordination in systems such as $AlO_{1.5}$-SiO_2 and a four-fold coordination in aluminophosphate glasses. In ordinary borate, silicate and germanate glasses, both coordinations exist. It might be even possible for some aluminum atoms to assume a five-fold coordination. The coordination number of aluminum in pure aluminate glass has not been known, even though one may speculate that the four-fold coordination probably predominates. During the search of new glasses for novel optical properties, the author has synthesized a number of aluminate glasses and one evidence based on the optical properties was noticed to justify the above speculation. These are described in the following sections.

In Table I, the refractive index, n, and Abbe value, ν, $[(n_D-1)/(n_F-n_C)]$, of some crystals and glasses of particular interest to the present discussion are listed.

The data in Table I are also plotted in Figure 1 in the conventional way of classifying optical glass: refractive index vs. Abbe value. The regions of ordinary commercial glasses and those newly developed by G. W.

TABLE I

	n	ν	Remarks
Crystalline $AlO_{1.5}$ (or Al_2O_3, corundum)	ω1.768[5] ε1.760[5]	71[6] 72[6]	All Al in 6-fold coordination.
Crystalline MgO	1.73790[7]	53.5[7]	
Syn. $MgAl_2O_4$ Crystal	1.7258[8]	63.5[8]	At least ½ of Al in 6-fold coordination.
$AlO_{1.5}$—component in silicate glasses	1.53[9]	56[9]	Possibly more in 4- than in 6-fold coordination.
Crystalline CaO	1.837[5]	46[10]	
Ca-aluminate type of Glasses (Table II)	~1.70	~44	Mostly 4-fold coordination.

Morey, as well as those of the author, are indicated. Glasses with optical properties outside these regions are often desirable from the viewpoint of optical design. When a piece of synthetic spinel crystal, $MgAl_2O_4$, was available and its optical properties supplied by Mr. P. T. Scharf, it was very interesting to note its relative position with respect to that of crystalline MgO and $AlO_{1.5}$(or Al_2O_3) in Figure 1. Many aluminate glasses of the Ca-aluminate type were synthesized (Table II) in the "hope" of producing glass with optical properties somewhere in between that for crystalline CaO and $AlO_{1.5}$. This "hope", however, was against theoretical expectation when one considers the coordination states of aluminum in glass as indicated by the position "glassy" $AlO_{1.5}$ occupies in Figure 1 when it is introduced as a component in ordinary silicate glass. The experimental result as indicated in Table I and Figure 1 justifies the latter viewpoint. The optical properties of aluminate glasses of the Ca-aluminate type are entirely different from what one would expect from the crystalline behavior of its components. It is true that the optical data for aluminate glasses are based on those containing also components such as MgO, BaO, $LaO_{1.5}$ in addition to CaO and $AlO_{1.5}$. These components however, would either tend to increase the refractive index and Abbe value or to cause little effect on these properties for a pure Ca-aluminate glass. The result clearly indicates that the coordination states of aluminum in spinel and in aluminate glasses are entirely different. It may be reasonable to assume that most of aluminum atoms in aluminate glasses take four-fold coordination. If this is the case, the contribution to the refractive index and Abbe value of a glass by the four-fold coordinated aluminum oxide would be in the neighborhood of 1.5 and 42, respectively.

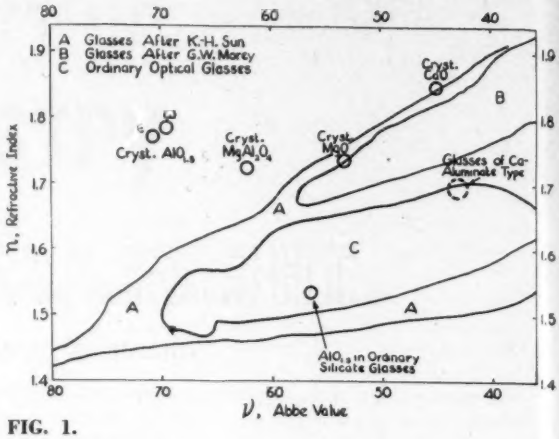


FIG. 1.

In the study of optical properties of borate glass, the author has noticed that the introduction or formation of B(4) in borate glass increases the refractive index and Abbe value. From a similar behavior in the case of aluminum described above, one may derive the following empirical rule: *the refractive index and the Abbe value of a glass increase as the coordination number of the positive element or elements* (such as B, Al, Ti, Co, Ni, K) *increases and vice versa.* This rule is a very practical and useful one and has enabled the author to develop a glass with relatively low refractive index and low Abbe value by reducing the coordination number of Ti from 6 to 4. A group of the so-called "super-flints" resulted, which will be revealed by the Kodak Research Laboratories through an article by Kinslake and DePaolis to be published in *Nature.*

Although the search for unusual optical properties in aluminate glasses was a satisfying failure, it results in a group of glasses which is unusual from composition point of view. These glasses are listed in Table II. Compositions are given in weight percentages (W) as well as cationic percentages (C). The latter, often adopted by the author for theoretical considerations, is identical with the so-called "mole" percentages if all the component oxides of the glass are expressed in the empirical formula, MO_k where k may be integers or half integers. All the glasses listed can be melted in a platinum crucible at a temperature 1450°C. or lower. Although no measurements were carried out to determine physical properties other than refractive indices, it seems that these glasses have much lower viscosity and higher co-

(*Continued on page* 232)

TABLE II

Some Experimental Aluminate Glasses

	1 W	1 C	2 W	2 C	3 W	3 C	4 W	4 C	5 W	5 C	6 W	6 C	7 W	7 C	8 W	8 C	9 W	9 C	10 W	10 C	11 W	11 C	12 W	12 C	Melting Points, °C.
$LiO_{0.5}$	3.6	12			1.0	4	1.0	4																	1700
$KO_{0.5}$			10.7	12																					
MgO	4.0	5	3.7	5	3.5	5	3.3	5	3.5	5.1	3.2	5													2800
CaO	28.0	25	26.0	25	24.6	25	23.0	25	24.2	25.3	22.0	25	34	37.0	33	35.9	31	34.5	34	35.4	26	27.6	18	19.9	2572
ZnO									9.0	6.5															1975
SrO	10.4	5	9.6	5	23.6	13	8.5	5	16.9	9.6	8.2	5													2430
CdO											24.2	12	12	5.7	6	3.5	6	3.6	6	3.4	6	3.5	5	2.9	1559 (S.P.)
BaO	15.4	5	14.2	5	13.4	5	32.6	13	13.2	5.0	12.1	5	14	5.6	10	4.0	11	4.5	12	4.6	12	4.6	12	4.8	1923
$LaO_{1.5}$															10	3.7	12	4.6	10	3.6	21	7.7	32	12.1	2315
BeO	10.0	20	9.3	20	8.8	20	8.2	20	8.6	20.2	7.9	20	3	7.3	3	7.3	3	7.5	8	18.7	13	30.9	16	39.6	2520
$AlO_{1.5}$	28.6	28	26.5	28	25.0	28	23.4	28	24.6	28.3	22.4	28	37	44.4	38	45.5	37	45.3	30	34.4	22	25.7	17	20.7	2015
n, Ref. Ind.																1.7016		1.7052				1.7453		1.7707	
ν, Abbe Value																43.8		43.7				44.4		44.9	

A.C.S. RETURNS TO CINCINNATI FOR ANNUAL MEETING AFTER SEVEN YEARS

In his message to the membership of the American Ceramic Society on the program of the 51st Annual Meeting, President Whittemore states that the Annual Meetings are now averaging double their prewar size. It is, of course, for this reason that for the first time all of the various Divisions which make up the Society cannot hold their individual meetings under one roof but must make their headquarters in three different hotels in Cincinnati.

Society headquarters will be in the Netherland Plaza Hotel where registration will take place and all general functions will be held. However, the Glass Division will be quartered at the Hotel Gibson and the Refractories Division at the Hotel Sinton. All other Divisions—Enamel, White Wares, Structural Clay Products, Design and Materials and Equipment—will conduct their meetings at the Netherland Plaza. Room accommodations will also be available at the new Terrace Plaza, the Fountain Square and the Metropole hotels.

Preceding the divisional meetings, the usual pattern of Annual Meetings will be followed. The Ceramic Educational Council will hold its session Sunday morning, April 24. The Institute of Ceramic Engineers and the Ceramic Camera Club will meet in the afternoon. The Student Speaking Contest will be held concurrently. The usual President's reception will be held Sunday night.

The General Session will be held Monday morning, the 25th, at which time Frank H. Riddle will deliver the Orton Lecture. J. O. Perrine of the Bell Telephone Laboratories will also speak at this session.

Keramos will meet for a luncheon on Monday and school dinners will be held in the evening of the same day. Entertainment and a dance is scheduled for Monday night.

The Glass Division luncheon will be held Wednesday, April 27, 12:30 P.M., at the Roof Garden of the Hotel Gibson.

The General Luncheons are slated for Tuesday and Wednesday and the General Banquet is to be held Tuesday night at which time President Whittemore will give his report to the Society and new officers will be installed. The annual dinner of the Board of Trustees will be held Wednesday evening, the 27th.

A program of entertainment has been developed and plant trips have been arranged. Although the plants selected for a visitation have no specific interest from a glass standpoint, glassmen may wish to take advantage of these trips. The plants to be visited are Armco Steel Corporation, Middletown; Rockwood Pottery and Cambridge Tile Manufacturing Company, Cincinnati.

Local Committees of the Meeting are as follows: *Honorary Committee:* Stanley G. Burt, Box 812, Stuart, Fla. and MacDonald C. Booze, Charles Taylor Sons Co., Cincinnati, Ohio. *General Committee:* R. B. Carothers, Chairman, H. C. Spinks Clay Co., Cincinnati, Ohio; Krell Bosler, Vice-Chairman, John Douglas Co., Cincinnati, Ohio; J. J. Canfield, 2909 Orlando Dr., Middletown, Ohio; Harold S. Nash, University of Cincinnati, Cincinnati, Ohio; Fraser B. Rhodes, 7134 Maple Ave., Madiera, Ohio and Robert W. Knauft, Charles Taylor Sons Co., Cincinnati, Ohio; *Women's Committee:* Mrs. R. B. Carothers, Chairman, Mrs. Edw. L. Bohn, Mrs. M. C. Booze, Mrs. Krell Bosler, Mrs. Chas. Burchenal, Mrs. Carl Deyerling, Mrs. Edw. A. Grannen, Mrs. Mary L. Jeffers, Mrs. Edw. J. Klocke, Mrs. Robert Knauft, Mrs. Harold Nash, Mrs. Fraser Rhodes, Mrs. Karl Smith and Mrs. Jas. Thompson. *Entertainment Committee:* R. B. Carothers (Monday night); Fraser B. Rhodes, (Sunday night); Krell Bosler (Monday night) and J. J. Canfield (Tuesday night). *Publicity:* Robert W. Knauft and *Host to Students:* Harold S. Nash, Chairman. (Assisted by the younger men from each plant.)

With regard to the Division programs, aside from the fact that the different divisions will be housed in several hotels, the only other deviation from past procedure is that a joint session on glass plant refractories will be held with the Refractories Division.

Abstracts of papers to be presented at the meetings of the Glass Division, the Refractories Division's joint refractories session and three papers of the Symposium on Physical Chemistry follow:

GLASS DIVISION PROGRAM

Monday Afternoon, April 25, 1949
2:00 P.M.-5:00 P.M.
Gibson Hotel—Roof Garden

1. A Study of the Adherence of Molten Glass to Heated Metals. *By J. A. Kapnicky, H. V. Fairbanks and W. A. Koehler, West Virginia University.*

A kinetic test for evaluating the adherence of molten glass to metal was devised. The results are expressed in terms of the highest metal temperature at which a drop of molten glass shows no adherence. This temperature was determined for several cast irons and nonferrous metals and alloys. It was found that this temperature was affected by the structure and surface roughness of the metals investigated. The effects of cyaniding, carburizing, nitriding, quenching and annealing were determined. The general effect of mold lubricants on the adherence temperature is indicated. Motion picture studies were made.

2. Stresses in Glass-Metal Seals. *By F. W. Martin, Corning Glass Works, Corning, N. Y.*

Consideration of the effects of viscous flow in the annealing range leads to new and interesting results. The total effect of viscous flow in cooling a seal following its annealing treatment has been calculated for a number of seal shapes. It has been found that the temperature at which the glass apparently sets up depends on the real shape as well as the viscous properties of the glass and the cooling rate. Anomalous results reported in the literature are explained when the effects of viscous flow are properly considered. With certain seal shapes, analysis along these lines leads to the selection of a glass having an appreciably different expansion from that customarily employed.

3. Effects of Radiant Heating on Glass Working Production and Equipment. *By H. R. Richardson, Westinghouse Electric Corp., Bloomfield, N. J.*

All glass working operations after the melting and firing must take into consideration the strain and annealing points of the glass. All initial forming operations from the molten glass take place at temperatures above the strain point; subsequent handling, however, may be in either of two categories according to whether the temperature of the operation 1)

is in excess of the strain point or 2) is less than the strain point. In production quantities, tradition has made these processes, especially annealing from above the strain point, a long time- and space-consuming job. Proved theoretical deductions indicate that time and equipment need be only a fraction of that in current use. To approach the theoretical time needed, each individual piece of glass must be assured the same treatment. Several illustrations are given of radiant installations covering a variety of operations where the article is given uniform treatment and the theoretical time of operation is approached. Four types of radiant burners are noted: 1) for open operation, 2) trough operation, 3) for inclusion in furnace and lehr walls and roofs, and 4) a nozzle mixing type for very large capacities. Discussion is made of theoretical and practical heat distribution. The various means of controlling the gas-air input are noted and compared.

4. Glass Research at the A.S.H.V.E. Laboratory. *By George V. Parmelee and W. W. Aubele, A.S.H.V.E. Laboratory, Cleveland, Ohio.*

Research has been conducted at the laboratory of the American Society of Heating and Ventilating Engineers under the direction of the technical advisory committee on Heat Flow Through Glass. A short review of this work will be given with a description of the special colorimeter and measuring equipment used.

CONCURRENT GLASS DIVISION SESSION

Tuesday Forenoon, April 26, 1949
9:30 A.M.-12:30 P.M.
Gibson Hotel—Roof Garden

5. Determination of Calcium Ion in Extracts Obtained from Chemical Durability Tests on Glass. *By Sudihir Sen and F. V. Tooley, University of Illinois, Urbana, Ill.*

The purpose of this study was to establish a method for the determination of calcium ion, suitable for application to glass extracts. The oxalate-permanganate method proved satisfactory. Essentially the method consists of precipitating the calcium ion as oxalate at a suitable pH, filtering, washing, and dissolving the precipitate in 9*N* sulfuric acid. Standard potassium permanganate was added and the excess determined photometrically after proper dilution.

The zinc-urany-acetate method for sodium and the molybdenum blue method for silica were studied as to possibilities of increased sensitiveness; the purpose was to permit application of these methods to smaller volumes of durability extracts. Several determinations of Na_2O, CaO, and SiO_2 were made on extracts from soda-lime-silica glass.

6. The Effect of Relative Humidity on Glass Surfaces Studied by Photographic and Transmission Techniques. *By G. F. Stockdale and F. V. Tooley, University of Illinois, Urbana, Ill.*

The progressive attack on polished glass surfaces caused by exposure to high humidity conditions was studied with photomicrographs and by measuring visible light transmissions. Carefully polished specimens of five commercial glasses representing a wide range of chemical durability were exposed to relative humidities of 95, 73, and 57% at 90°C. for a total of 1296 hours. Photomicrographs taken at frequent intervals show the degree of surface alteration as a function of time and humidity and furnish some basis for characterizing the course of weathering. For some glasses, the transmission losses did not correlate simply with the amount of visible attack; frequently gains in transmission were noted as the attack progressed. One glass in particular exhibited a general transmission gain of 1% after 24 hours of weathering and maintained this gain throughout the tests. Surface films produced on the least resistant glasses caused greater transmission loss in the blue region of the visible spectrum than in the red. Following a dilute acid wash, transmission approached or in some cases exceeded values characteristic of the original polished condition.

7. A Study of the Effect of Cation Concentration and Size of the Helium Permeability of Alkali-Silica Glasses. *By T. F. Newkirk and F. V. Tooley, University of Illinois, Urbana, Ill.*

A study was made of the effect of systematic variations in the alkali cation concentration and size on the permeability of alkali-silica glasses to helium at 300°C. Permeability determinations were made on fused silica, chemical Pyrex, Na_2O-SiO_2 glasses containing 20, 25, and 30 mol per cent Na_2O, K_2O-SiO_2 glasses containing 30 mol per cent K_2O, and a Li_2O-SiO_2 glass containing 5 mol per cent Li_2O and 25 mol per cent Na_2O.

Additions of Na_2O to SiO_2 glass produced a rapid decrease in the permeability of the glass. The permeability was found to decrease exponentially with increasing molar per cent Na_2O over the range 0 to 30% Na_2O. The substitution, atom for atom, of potassium for sodium increased the permeability of the glass, while lithium in combination with sodium decreased the permeability as compared with the soda glass. This was attributed primarily to the difference in the polarizing power of these cations affecting the ionic radius of the surrounding oxygens resulting in a change in the packing density of the ions in the glass.

A comparative packing index was calculated for the glasses based on the percentage of the absolute volume of glass contributed by the constituent elements. For the Na_2O-SiO_2 glasses, increase in packing index (indicating a more closely packed structure) was accompanied by a decrease in permeability. It is suggested that the comparative packing index is a potentially valuable index of permeability only for glasses containing the same atoms; that new atoms introduce a new polarizing factor in the glass, and the packing index ceases to be comparative for the two glasses.

8. The Relationship between Variations in Glass Furnace Level and Gob Weight in Feeder Operation. *By T. W. Griffin, J. S. Light and A. W. Russell, Hartford-Empire Co., Hartford, Conn.*

Methods of calculation are presented to allow prediction of the variation of rate of flow of glass through feeder orifices as a result of level variations, and results compared with test data of feeder performance.

The data show that other than very slow variations in level result in variations in glass temperature which, in turn, act to amplify the weight variation that would result from a slow change in level.

For the commonest type of feeder, level variations of 0.075 in. are shown to have caused weight variations ranging between 1 and 25%, the larger variations applying in the case of the more rapid level changes.

9. Viscosity and Density of Molten Optical Glasses. *By L. Shartsis and S. Spinner, National Bureau of Standards, Washington, D. C.*

The viscosities of a number of optical glasses representing all types produced at the National Bureau of Standards were measured with a counterbalanced sphere method. In this method the relative velocity of a platinum sphere suspended in the molten glass from one arm of an analytical balance is measured by observing the motion of the balance pointer. The apparatus is simple and rugged and has the additional advantage that densities of the test liquids can be calculated from the data used for calculating viscosities. Density data obtained by this method agreed well with those obtained by a volumenometer method.

CONCURRENT GLASS DIVISION SESSION ON THE STRUCTURE OF GLASS

Tuesday Afternoon, April 26, 1949
2:00 P.M.-5:00 P.M.
Gibson Hotel—Roof Garden

10. Study of Structure and Physical Properties of Some Boroaluminate Glasses. *By N. Chandappa and H. E. Simpson, Department of Glass Technology, New York State College of Ceramics, Alfred, N. Y.*

A study of the properties of some boroaluminate glasses was made in order to ascertain the field of glass formation, and determine physical properties of such glasses.

The field of glass formation in the System B_2O_3–Al_2O_3–Na_2O was first located. Then a series of glasses was made in which the sodium oxide content was replaced by alumina

on a molecular percentage basis and boric oxide held constant. Physical properties were determined, such as expansion, viscosity, refractive index, and density. The composition-property curves show deviations between 7.5 and 10 molecular percentage of alumina. It is believed that these deviations were caused by the change in coordination of boron. To verify this reasoning, 1% of sodium uranate was introduced in all the glasses considered in the property studies, and fluorescent spectra and transmission curves of these glasses were obtained. The results of these data indicated that the above reasoning was true.

A discussion is presented of the probable structure and change in structure of these glasses. Suggestions are also made for future work.

11. Investigations of the Structure of Glasses by Infrared Reflection Techniques *By Scott Anderson, Anderson Physical Laboratory, Champaign, Ill.*

Infrared reflection curves from a number of glasses are presented. It is apparent that in some cases such a method may be a useful tool in determining the atomic arrangement in glasses. The spectra of barium-containing silicate glasses show that these glasses are composed of two networks. One network is obviously the silica tetrahedron and the other is probably a six coordinated barium. This latter is concluded by comparison with a reflection curve for bentonite. Reflection spectra of boric oxide glasses are presented. From these it can be concluded that even in pure boric oxide glasses, an appreciable portion of the boron is tetragonally coordinated. This conclusion is contrary to the previously drawn conclusion from X-ray scattering data. Nevertheless, it is shown that those data may be easily interpreted to give the same conclusion.

12. Radioactive Tracer Methods Applicable to Ceramic Research. *By James R. Johnson, The Ohio State University, Columbus, Ohio.*

Basic principles and properties of radioisotope disintegration are presented as a background. A discussion of instruments for measuring the disintegrations and a summary of tracer methods follow. Ceramic research applications, including several schemes of assay, are then given for consideration.

13. The Application of Rate-Process Theory to Glass: II, Viscosity. *By F. B. Hodgdon and D. A. Stuart, University of Utah, Salt Lake City, Utah.*

In previous efforts to derive an equation for the temperature-viscosity relation of glass it has been assumed, tacitly or otherwise, that glass is a simple liquid. Since glass is not a simple liquid, it is necesary to find a model that will, in its reaction to applied stresses, have the same characteristics as a specimen of glass. By the use of Eyring's rate-process theory such a model is proposed and several equations relating viscosity to time and to temperature are derived. The equations include an equation that relates the viscosity of a glass specimen having no internal strain to time, an equation defining the rate of removal of internal strain, and an equation relating the viscosity of any specimen, with or without internal strains, to time. These equations are valid under conditions of constant temperature only. The equation that is derived for the relationship of viscosity to time for specimens of glass under all conditions of internal strain, is reduced to an equation at infinite time after the beginning of the experiment. This is the value of viscosity usually reported in the literature. It is found that the parameters in the reduced equation can be calculated from the chemical composition of the glass and the viscosity of any given glass can be predicted at any temperature over a wide range. A sample calculation is included to demonstrate the use of these parameters in the calculation of viscosity. Curves and tables are included to show the agreement of experimental and theoretical values.

Wednesday Morning, April 27, 1949
9:30 A.M.-12:30 P.M.
Roof Garden

14. Determination of Volume Expansion of Glass at High Temperatures. *By A. G. Johnson, S. R. Scholes and H. E. Simpson, Department of Glass Technology, New York State College of Ceramics, Alfred, N. Y.*

The results of previous investigators on the volume measurements of glass at high temperatures have been quite limited. The work, however, of several investigators is presented.

A technique was developed for the determination of the volume expansion of glass at high temperatures. By the application of the Jolly Balance, the change in density of the glass with change in temperature was measured over a temperature range 925° to 1300°C. The technique developed can be used only at high temperatures, but it was shown to give reasonably good reproducible results. From the data attained, it was concluded that glass has no discontinuity of properties as it cools through the annealing range. Suggestions for the improvement of the apparatus, as well as improvements in the experimental technique were made. It was recommended that determinations of volume expansion over a temperature range of 500° to 900°C. be made in order to enhance and complete the results.

15. A Recording Dilatometer for Measurement of Thermal Expansion. *By J. C. Turnbull, Radio Corp. of America, RCA-Victor Division, Lancaster, Pa.*

A recording dilatometer is described, in which a resistance strain gauge is used for the measurement of linear thermal expansion. The recording feature is obtained with a conventional recording potentiometer, which prints the strain gauge output directly, together with the sample temperature. The accuracy attainable is better than ±0.5% of full scale.

16. The Effect of a Tank Design Change on the Glass Flow. *By F. L. Bishop, American Window Glass Co., Arnold, Pa.*

A change in design of the melting and refining sections of a large Fourcault tank was made in 1947. Measurements of the flow by the addition of cerium hydrate were made before and after the change. The method is the one previously (*J. Am. Ceram. Soc.* **28** [11] 308-310 (1945)) described. Curves are included showing the effect of the change.

17. Effect of Additions of Polyvalent Elements on the Surface Tension of a Simple Glass. *By C. R. Amberg, The New York State College of Ceramics, Alfred, N. Y.*

The ions of V, Cr, Co, Ni, As, Mo, Sn and Pb as well as the phosphate and sulfate ions were added in 0.001, 0.01, and 0.05 molal quantities to a simple glass of the composition $Na_2O{\cdot}2{\cdot}2SiO_2$. Surface tensions were determined by the maximum bubble pressure method at a series of temperatures. The effects of concentration change proved interesting and seem to show relationship to the state of oxidation.

Wednesday Afternoon, April 27, 1949
2:00 P.M.-5:00 P.M.
Roof Garden

18. Effect of Addition of ZnO on Properties of Soda-Lime-Silica Glasses and Methods of Introducing it into a Glass. *By A. R. Khan and H. E. Simpson, Department of Glass Technology, New York State College of Ceramics, Alfred, N. Y.*

Zinc oxide is known to contribute a number of desirable and unusual properties to glass. In order to determine the influence of ZnO in glasses, substitutions for silica were made beyond the range of normal application.

Zinc oxide was substituted for SiO_2 in a base glass of composition: SiO_2-75%, Na_2O-16%, and CaO-9%. Substitutions were made in intervals of 2% up to a total of 20%. Physical properties such as Littleton softening point, thermal expansion, density, and chemical durability were determined. Beneficial effects were noted up to 10% substitutions. These results have been confirmed by other investigators as well. Beyond 10% substitution the resistance to attack by acid decreased and the thermal conductivity increased slightly. Most physical properties showed a pronounced change at 16% substitution suggesting the possibility of the formation of a zinc silicate.

With glasses high in zinc, it was found considerably advantageous to flux the zinc, prior to melting, with B_2O_3. By adding zinc as a zinc borate, two distinct advantages were realized: 1) the raw batch was easier to mix and 2) the time required to melt and fine the glass was reduced considerably.

The work of other investigators is presented and suggestions for future work are given.

19. Decomposition of Glass by an Acid Leaching Solution. *By G. E. Lorey and H. E. Simpson, Department of Glass Technology, New York State College of Ceramics, Alfred, N. Y.*

A method was studied for determining the rate of release of the soluble elements in a glass to an acid leaching solution. The measurement of the durability of glass does not involve the true solubility of the glass, but rather the rates of reaction and the selective solution of reaction and the selective solution of ions from the glass. It was hoped that this information would reveal more clearly the mechanics of the decomposition of glass and also serve as a measure of its durability.

An acid leaching solution (0.02 *N* HCl) was run through a column of powdered glass at a temperature of 50°C. Soda and silica removed from the silica gel on the surface of the glass were determined gravimetrically. It was found that the sode and silica were present in the extractions in a ratio (SiO_2:Na_2O) greater than a sodium metasilicate relationship and less than the amounts present in the original glass. By successive analysis of the leaching solutions, curves were obtained showing the rate of removal of soda and silica. With progressive leaching, the reaction slowed down to a constant rate, probably because of the adsorbing power of the increasing silica film. Determinations were made on three glasses typical of those used in the flat glass industry. One was a plate glass and the other two were window glasses.

20. Business Session.

REFRACTORIES DIVISION PROGRAM

Monday Afternoon, April 25, 1949
2:00 P.M.-5:00 P.M.
Sinton Hotel—Ballroom

2. Blast Furnace Brick Disintegration Equipment and Test Procedure. *By J. A. Shea, Gary Steel Works, Carnegie-Illinois Steel Co., Gary, Ind.*

JOINT SYMPOSIUM WITH GLASS DIVISION ON REFRACTORIES IN THE MANUFACTURE OF GLASS

Tuesday Forenoon, April 26, 1949
9:30 A.M.-12:30 P.M.
Ballroom

7. Refractory Problems in Glass Manufacturing. *By Henry H. Blau, Federal Glass Co., Columbus, Ohio, and Ohio State University, and Carl D. Smith, Federal Glass Co.*

In spite of recent progress and developments, refractories still constitute a limiting factor to many aspects of modern glass manufacturing. Present requirements emphasize not only the technological and engineering approaches, but also the shifting economic problems arising from existing and prospective trends in glass requirements, fuels and construction costs.

8. The Use of Clay Flux Blocks in the Glass Industry. *By C. L. Meloy and J. M. Lambis, Findlay Clay Products, Washington, Pa.*

The desirability of balanced design of a glass tank which is uniform in length of service in each of its parts is discussed. Temperature, chemical composition, structure, thermal conductivity, gas flow, and the methods available to combat attack are considered. The chief advantages of the use of clay blocks in their place are pointed out.

9. Development of Fused Cast Refractories and Their Applications to Glassmelting Furnaces. *By Harold W. Baque, Corhart Refractories Co., Louisville 10, Ky.*

This paper discusses the development of the use of fused cast refractory materials for strengthening weak spots in glass tank furnaces. A gradual trend is noted toward the use of super-refactories throughout such furnaces with resulting increases in life and product output. Photographs illustrating this trend are shown.

10. Physical Properties of High Alumina Fused Cast Refractories. *By J. C. McMullen, Research Department, The Carborundum Co., Niagara Falls, N. Y., and A. Paul Thompson, Mellon Institute, Pittsburgh, Pa.**

The physical properties of certain high-alumina electrically fused cast refractories are presented and the significance of these to the glass industry in terms of their applicability to glass tank construction is pointed out.

* Present address: Research Department, The Eagle-Pitcher Co., Joplin, Mo.

11. Glass Furnace Upperstructure Refractories. *By W. L. Fabianic, General Engineering Department, Owens-Illinois Glass Co., Alton, Ill.*

Current usage of refractories in the upperstructure of soda-lime glass container furnaces is summarized. By upperstructure is meant the tuckstones, breastwalls, port sills, port jambs, port arches, port sidewalls, port caps, port endwalls, port bottoms and main furnace crowns. It is recognized that other types of refractories, in addition to those mentioned, are being tried. However, only those that are really being used in an appreciable number of commercial installations are discussed.

Tuesday Afternoon, April 26, 1949
2:00 P.M.-5:00 P.M.
Ballroom

12. Refractories for Use in Glass Furnace Regenerators. *By Arthur E. Currier, Research Department, Harbison-Walker Refractories Co., Pittsburgh, Pa.*

This is a review of problems in glass tank regenerators and the types of refractories now being used for this purpose. Information concerning the use of fireclay, high-alumina and basic brick is discussed, together with pertinent service data.

13. A Note on Refractories for Regenerators. *By R. G. Abbey, General Refractories Co., Philadelphia, Pa.*

14. Study of Silica Brick from a Glass Tank Cap. *By E. S. Chrzan, E. C. Petrie and S. M. Swain, Research Department, North American Refractories Co., Cleveland 14, Ohio.*

Silica brick after service in a glass tank were carefully examined for alteration in chemical composition and in some physical properties. Test specimens were selected by color zones and other evidence of change. The results give information for a partial understanding of the mechanism of change brought about in various sections of a glass tank.

15. Refractories for the Glass Tank Forehearth. *By Robert W. Knauft, Charles Taylor Sons Co., Cincinnati 14, Ohio.*

16. Glass Corrosion Tests on Refractories. *By A. C. Siefert and J. J. Webber, Research Department, Owens-Corning Fiberglas Corp., Newark, Ohio, and F. V. Tooley, University of Illinois, Urbana, Ill.*

SYMPOSIUM ON PHYSICAL CHEMISTRY

Tuesday Forenoon, April 26, 1949
9:30 A.M.-12:30 P.M.
Meeting Room H

Original Papers Session (Partial list)

7. On the Surface Structure and Surface Properties of

(*Continued on page* 236)

REFRACTORIES FOR GLASS FURNACES

By W. F. ROCHOW

Harbison-Walker Refractories Co., Pittsburgh, Pa.

The service normally secured from refractories in many kinds of industrial furnaces, measured either in time or in tonnage, has become well established. However, wide variations in the life of the refractories are common rather than unusual in any particular practice. For example, the average life of refractories in iron cupolas, depending upon the operating conditions, may be hours, days, or even months; in electric steel-melting furnaces, days or months; in malleable furnaces, weeks; in rotary cement kilns, several months to several years; and in coke ovens, usually many years.

In most industrial furnace operations, the trend is toward greater production per unit of furnace volume, and toward the employment of higher temperatures to secure major improvements in the quality of products. The glass industry is no exception to this trend. Many continuous glass tanks are now operated at greatly increased rates of production, and at temperatures which were regarded as wholly impracticable only a few years ago. Furnaces designed to produce glass at the rate of one ton per day for each 10 to 12 square feet of melting area now are being operated at a rate of one ton of glass for each six or seven square feet, and in some instances even more. In recently designed tanks, a ton of glass per day for each five square feet of melting area is not exceptional for high loads.

MELTING RATES AND TEMPERATURES
TANK FURNACE MELTING COLORLESS GLASS
PERIOD 1919-1946

Year	Average Melting Rate (sq. ft. per ton per day)	Tank Life	Temperature
1919	16.8	2 years	1350°
1921	17.4	—	—
1923	15.7	—	—
1927	13.3	—	—
1929	12.1	—	1420°
1931	10.1	1 year	—
1933	8.6	—	—
1935	8.2	—	1480°
1937	7.2	1.5 years	1510°
1946	5.0	—	1570°

Adapted by adding 1946 data to data given by W. E. S. Turner; Jour. Soc. Glass Tech., April, 1938, Page 140.

FIG. 1

Glass of greatly improved qualities and new types of glass with special properties for specific uses are being produced on a commercial scale. Improvements in the design and construction of the glass-melting furnaces have contributed to these accomplishments.

Improvements in flux blocks have materially altered the traditional relationship between the service secured from the refractories in the superstructure and that secured from the tank blocks. Use of the improved tank blocks has made possible the operation of the tanks at much higher rates of production. Consequently, it has become necessary to use more refractory lining materials at certain critical points in the superstructure of the tanks and the regenerators. Refractories which were regarded as standard for these locations a few years ago are no longer adequate.

Operating Variables

In addition to the wide differences in furnace operating conditions which are governed by tank design and kind of glass produced, there are other variables which exert great influence upon the service rendered by the refractories. Such variables include changes in the batches, the amount of cullet used, changes in types of fuels, variations in temperatures and pressures, degree of combustion, and increased or decreased rates of production. The selection of refractories for a glass tank is largely based on the objective of securing balanced service from all parts of the furnace. This requires the choice of the particular refractory material best suited for each vulnerable position, where premature consumption of the refractory would necessitate hot repairs or might even bring the campaign to an end.

The severity of the treatment imposed upon the refractories in different parts of the furnace depends mainly upon the temperature and upon the amount and kind of alkaline dusts and fumes in the furnace gases. At high temperatures lime sodium salts and other materials used in the production of the glass react with the refractories and corrode them. Volatile alkalies are especially corrosive, because they readily penetrate into the pores of the brick. Borax used in the manufacture of certain glasses reacts vigorously with fireclay refractories at high temperatures, and sodium sulfate becomes extremely active as a flux in reducing atmospheres.

Entirely general rules cannot be followed in the selection of the refractories because furnace design, kind of glass manufactured and operating procedures differ widely from one plant to another. For any particular furnace, the selection of refractories must be governed by an understanding of the conditions which are expected to prevail during the coming run. Naturally, the choice is based upon general experience with the refractories in similar applications, and upon the behavior of the particular refractory in previous campaigns. For example, experience in Plant A may have proved that high duty fireclay brick are just a little short of adequate for use in the air checkers. Then from the point of view of economy, it is clear that super-duty fireclay brick should be used. However, in Plant B, even a 50% or 60% alumina brick may not have satisfactorily served the purpose in the

Paper presented before the Tenth Conference on Glass Problems, Ohio State University, Columbus, Ohio.

campaign just completed. In that event, the use of a better and frequently more costly refractory is warranted.

Commercially Available Refractories

The types of refractories available for the superstructure and regenerators of modern glass tanks include a wide range of materials. Among the alumina-silica refractories are high duty and super-duty fireclay brick and high-alumina brands of 50%, 60%, 70%, 80%, 85% and 90% alumina. Most of those of the 50%, 60% and 70% classes are made principally from diaspore. Distinct varieties of high-alumina brick are made wholly or largely from the minerals kyanite or sillimanite which are readily converted to mullite in the heat treatment they receive upon firing in the kilns. Other high-alumina refractories consist of diaspore and crystalline alumina, or corundum; such refractories include 60% alumina brick and those containing 80 and 85% alumina. In the 90% alumina class, there are several brands consisting of corundum with a mullite bond. A relatively recent development is a refractory made entirely of corundum, which contains 99% alumina.

SUPER-DUTY HIGH-ALUMINA BRICK

Approximate Alumina Content	60%	85%	90%
Pyrometric Cone Equivalent	37	39-40	39-40
Porosity	17-19%	25-27%	23-25%
Modulus of Rupture	1200-1600 psi	1800-2000 psi	900-1200 psi
Reheat Test			
Linear Change (1600° C.)	0 to —0.5%	—0.5 to —1.0%	0 to +0.3%
Load Test			
Subsidence (1450° C.)	1 to 1.6%	....	0
(1550° C.)			1.6%
Panel Spalling Test			
Loss (1650° C. Preheat)	0 to 3%	....	0

FIG. 2

All alumina-silica refractories, including high duty fireclay brick of the usual burn, contain appreciable amounts of mullite. High duty fireclay brick of special hard burn corresponding to that of the so-termed "double burned" super-duty brick are now available. The physical properties of these seem especially interesting for use in parts of glass furnaces. Alumina-silica refractories with less than about 70% alumina contain some free silica, mainly in the form of cristobalite.

In the presence of soda borne by furnace gases, refractories consisting of alumina and silica are susceptible to the formation of the mineral nephelite ($Na_2O \cdot Al_2O_3 \cdot 2\ SiO_2$) over a relatively low, critical temperature range. The formation of this mineral in surface zones accounts for much of the slabbing which sometimes occurs in glass furnace linings. Slabbing is a phenomenon different from fluxing of refractories by alkalies at high temperatures. Any zone in which an appreciable proportion of nephelite has formed has a higher thermal expansion than the unaffected portion of the brick. It is this difference between the thermal expansions and the growth incident to the formation of nephelite that cause the altered zone to shell off.

At highest operating temperatures, in the presence of volatile alkalies and alkaline dusts, mullite present in refractories decomposes leaving a spongy zone of corundum.

Fig. 3. Two slabs from a checker brick and a portion[1] of the remaining brick core.

This fact suggests that, so far as the composition of the refractory is concerned, corundum may prove to be the ultimate in resistance to the destructive factors prevailing in parts of glass furnaces. However, its use may be confined largely to the most vulnerable portions of the construction.

Composition alone, while of utmost importance, does not afford a safe criterion as to the quality of a refractory. The physical properties, such as density, strength, stability of volume at high temperatures, and spalling resistance must be taken into account in the selection of refractories for any particular service condition.

Silica Refractories

Silica refractories possess certain pronounced physical properties peculiar to this type alone. Their high thermal expansion could be interpreted as undesirable. Yet the shrinkage of many other refractories at high temperatures is extremely undesirable for many applications. The expansion of silica brick is definite and is readily provided for in its use in furnace structures. Fortunately the expansion is such that it precludes all danger of spalling above the temperature of about 1200°F. Its strength at high working temperatures largely accounts for its universal use for certain specific purposes.

During the past six or eight years, super-duty silica brick have come into extensive use. The essential difference between these brick and conventional silica brick is their lower content of impurities. This accounts for their greater strength at high soaking heats and their appreciably higher refractoriness and greater resistance to the action of fluxes.

[1] C. L. Thompson and E. P. Rexford. "A Study of an Alumina-Silica Checker Brick from the Regenerator of a Glass Tank" Journal of the American Ceramic Society Vol. 21, No. 2, February, 1938.

MELTING TEMPE TURE - DEGREES FAHRENHEIT

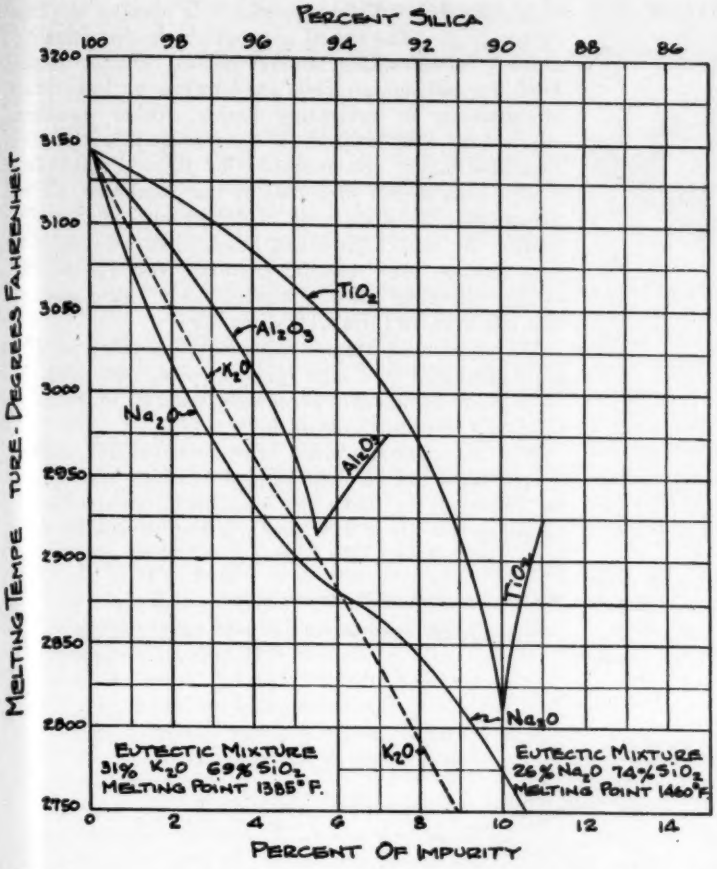


Fig. 4

Figure 4 showing curves illustrates the effect of various oxide impurities upon the melting behavior of silica.

Basic Refractories

Several classes of basic refractories are used to advantage in parts of glass tanks, primarily for checkers and in the construction of regenerator walls and arches and also in ports.

These classes include: 1) chemically-bonded magnesite-chrome brick, in which magnesia is the predominant constituent, 2) chemically-bonded chrome-magnesite brick, which contain more chrome than magnesite, 3) chrome-magnesite brick of a special very hard burn, 4) brick consisting of the magnesium-silicate mineral, forsterite, which are also fired at a high temperature, and 5) hard-burned magnesite brick. All these are amply refractory and have non-wetting properties; that is, they do not tend to hold in the form of accretions, batch dust which is carried over, and thus remain free from accumulations which cause clogging of checkers. They are highly resistant to the fluxing action of alkalies.

The chromic-oxide content in some cases has been regarded as objectionable because of the danger of discoloration of the glass.

Chemically-bonded magnesite-chrome brick depreciate in strength at the temperatures which prevail in checker chambers, regardless of the kind of atmosphere present. Chemically-bonded chrome-magnesite refractories promise to perform better in this respect. The hard-fired chrome-magnesite brick and forsterite brick retain their strength under similar conditions, as do the hard-burned magnesite brick which are produced and used in Canada.

Not any of these basic refractories is immune to the deleterious action of reducing atmospheres, which is all the more pronounced within a critical range of temperatures. Alternate oxidizing and strongly reducing atmospheres seriously affect the strength of all basic refractories yet developed. Consequently, they are not recommended for checkering gas chambers in producer gas-fired tanks.

Cap Construction

Silica is the refractory material universally used for cap construction with but very few exceptions for special conditions. High-alumina brick caps are sometimes used on small furnaces making special glass. In recent years, silica brick have been improved by better methods of manufacture. As the result of power pressing, the workmanship is much better. More precise particle sizing along with the power pressing has been the means of lowering the porosity, and consequently decreasing the amount of alkali absorbed by the brick in service.

The phenomenon of boring, not infrequently experienced in caps, is caused by the penetration of volatile alkalies through the joints to a zone where the temperature is low enough to cause condensation. This condensation results in an accumulation of alkalies which flux the brick as they flow back to the exposed face. Boring occurs in its most pronounced form in tanks operated under positive pressure.

Fig. 5. Illustrating Boring in Tank Caps.

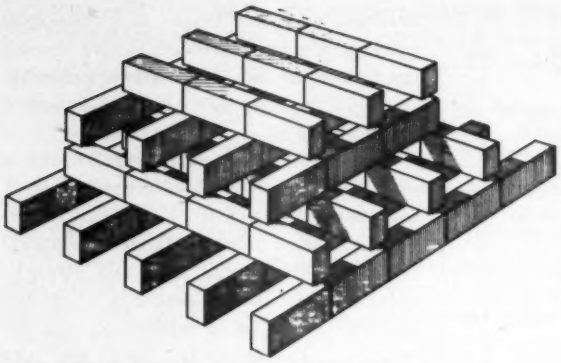


Fig. 6. Showing Conventional Open Setting.

The power pressed roof brick having very smooth surfaces, minimum warpage, and the highest degree of accuracy in dimensions can be installed with closer joints than was the case in the past with brick made by other methods. The tight fit of these brick overcomes the tendency toward boring.

Silica caps usually are 12 inches thick, although some caps are 13½, 15 or 18 inches thick. Brick of 6-inch rather than 9-inch widths are preferred for building caps, because with the lesser width, the brick are more nearly straight and consequently it is possible to make tighter joints. The use of a special high-silica bonding mortar, corresponding in refractoriness to that of the brick, for making thin joints and for grouting, has proved advantageous in preventing boring. Other measures which have been helpful in overcoming this excessive localized fluxing are provision for thermal expansion with a high degree of accuracy, and insulation, which presumably raises the zone of condensation to a point outside the cap. Lightweight silica brick are used for this purpose. Any material resulting from the fluxing of the lightweight silica, if fluxing occurs, is the same as that which would form from silica brick.

The presence of steam in the combustion gases, causing high luminosity and high heat radiation, can result in local overheating, and do serious damage to the cap brick in a very short time by fluxing.

With the super-duty silica brick now available, higher temperatures can be used without reducing the life of the structure; or, under the same operating conditions, longer service life will be obtained from super-duty than from conventional silica brick.

Walls, Ports and Regenerators

Silica brick continue to be used most extensively in

(*Continued on page* 234)

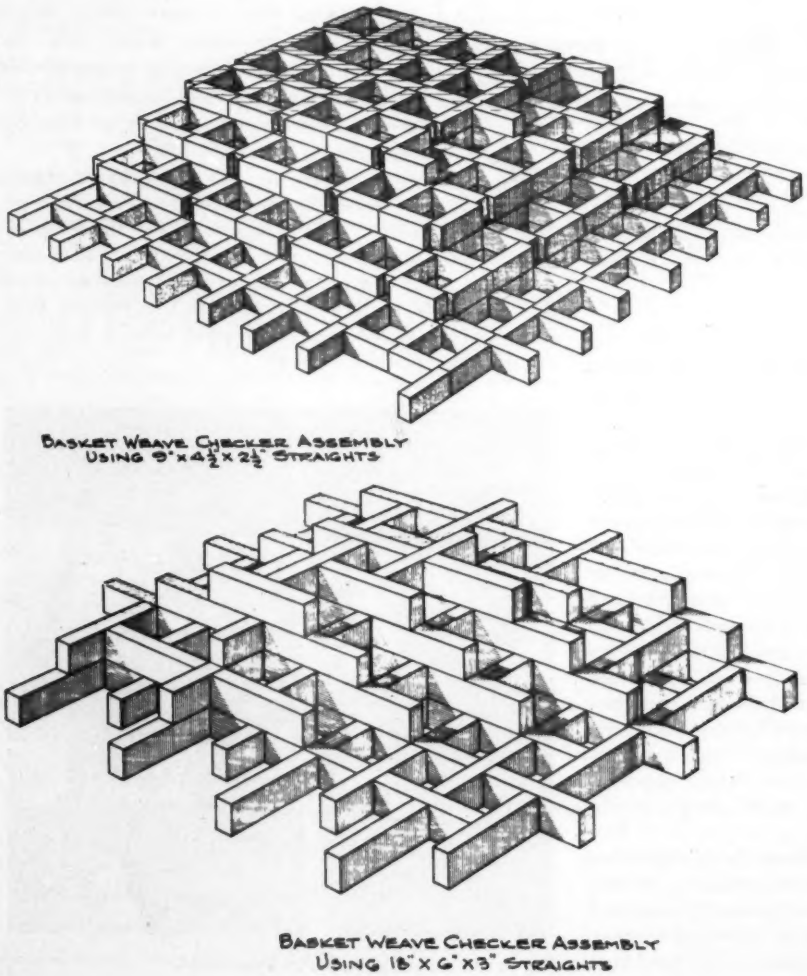


Fig. 7. Illustrating Method of Setting Checkers in Basket-weave arrangement with 9" straights (9 x 4½ x 2½ or 9 x 4½ x 3) in the one case and 18 x 6 x 3 straights in the other.

THATCHER'S MEN'S CLUB CREATES A GOOD NEIGHBOR POLICY

If it be true, as social students maintain, that most social organisms are a reflection of their environment, we quickly find convincing evidence and proof of it in the background of the unusual and distinctive employees' club of the Thatcher Glass Manufacturing Company of Elmira, New York.

This company, a big unit in the glass container industry with over one thousand employees and located in the small industrial city of Elmira (52,000 population), is actually located in the even smaller adjoining suburban village of Elmira Heights (population 6,000). Situated in a beautiful valley which is the gateway to the famed Finger Lakes Region and flanked on both sides by the rolling foothills of the Alleghenies in a community dignified by the memory of Mark Twain and Thomas K. Beecher and with the outdoors at everyone's doorstep, its employees proudly reflect their small town background and way of life: hominess, friendliness, personal independence and a healthy personal interest in their neighbors' doings, with a spontaneous urge to help each other when in trouble. The club formed by these employees some fifteen years ago was and still is a product of a small town American background at its best, and in the best early American tradition it pays its own way as it goes. It has always been self supporting without company assistance.

An employee's death fifteen years ago was indirectly responsible for the start of the Thatcher Men's Club. A popular young man on the machine floor died and some of his immediate fellow workers started a collection for flowers. Sympathetically, the collection spread beyond ordinary scope until the amount of some $75 was collected and all unthinkingly spent on one huge floral piece, while at the same time the deceased's family was actually desperately in need of ready cash!

The Employment Manager of Thatcher at the time was Wilfred J. (Bill) Davies who 17 years before had started on the machine floor and had worked his way up through every plant operation. His greatest interest in life was, and still is, people—just plain, ordinary, everyday people in whom he has a sincere, unselfish and unfailing interest and concern. Bill Davies had always been active in organized Sunday School work and he knew how much good could be accomplished by even a few people for themselves and for others working together on some planned and coordinated activity. From this he reasoned, why not have a thousand people with a common interest in the same company and spending a good part of their daily lives in contact with each other beneficially join together to cope with the ordinary, everyday, social occurrences of life? So, led by Bill Davies and for the original practical purpose of handling the matter of collections for flowers, a small group of employees got together and organized the Thatcher Men's Club which has since become an active, vital force in the lives of some 900 employees of the company and their families, affecting up to some 5,000 persons. It has become an influence in the small community far beyond the confines of the blowing room floor and since its inception, the simple, practical, useful character of the club has never changed.

There is no attempt to change or readjust the employee's life, the theory and practice being that paid fair wages under good working conditions, the average employee likes to live his own life and do things for himself in his own way. The Thatcher Men's Club largely goes its own way, and has never cost the company a nickel except for space within the plant allotted to employees for their club home. There has never been a strike at Thatcher and general labor conditions at the plant have always been conceded to be the best in the community.

The club fulfills its purpose and operates at its best when some member or his family is in personal trouble, a sickness or a bereavement, or some occasion that distinctly calls for the human touch and concern for one's neighbor. The interest of the club goes far beyond the formal sending of flowers during time of bereavement. Members of the club visit the home to see what needs to be done, and do it if necessary. The by-laws of the club forbid giving actual money to fellow employees but when necessary, practical equivalent help is given, such as buying and furnishing coal and groceries and paying rent. The company has, of course, a liberal hospitalization and sick benefit plan for employees.

Aside from its active and unflagging interest in welfare work, the club has a diversified program which includes three big social events each year and the sponsoring of athletic events and groups.

All this for five cents a week, the original dues which have never been raised. Dues are supplemented by income from milk and candy machines, the profit from which goes into the club treasury. Club income is divided into three parts: 40 per cent to the welfare fund, 40 per cent to social, 20 per cent to athletics, and with typical Yankee foresight and thriftiness, Bill Davies and his original founding group, in order to make sure the money isn't wasted just because it accumulates and to safeguard against an extravagant administration, provided that any

Air view of Thatcher Glass Manufacturing Company's plant at Elmira Heights, New York, where even parking is no employer-employee problem.

Three officers of the Club. Left to right: Vice President Roscoe Graves, Secretary-Treasurer Wilfred (Bill) J. Davies and President Raymond Ross.

balance over a set figure must go into Bonds for a sinking fund. The club now has nearly $5,000 par value of United States Bonds.

The annual report of the club for 1948 might well set an example for many a far greater enterprise because while helping a lot of people help themselves, it still wound up the year with a healthy balance and distinctly in the black. Income was $3,809.70 and disbursements, $2,909.88, leaving a balance of $899.82. Disbursements included: Welfare, flowers, $278.90, relief, $190.30; Social, Election party, $154.11, picnic, $624.58, smoker, $30.87, outing, $398.13, Christmas party, $848.88; Athletics, $391.18.

Before the start of the Red Cross Blood bank, the club provided donors whenever a member or some member of his family required a transfusion. Now the group actively supports the bank when the blood unit visits Elmira.

Another distinctive feature of the club is that since very few women worked in the Thatcher plant when the club was formed, it has never changed its policy of admitting men only. Women workers enjoy all the benefits and attend all the social affairs but are not eligible for membership.

The big summer picnic held annually at nearby Eldridge Park vies with the Christmas party in popularity. This family picnic is of the old-fashioned basket variety with all the concessions bought out for the children to freely use and enjoy.

It takes two separate nights to handle the ever popular annual Christmas party during which favors and presents are given by Santa Claus to more than 700 children up to the age of thirteen. But the big thrill for Mom and Pop and the kids, and the sort of thing that endears the club to them forever in their memory, is the opportunity for the children only to participate in an amateur program which gives Willie a chance to display his talents in front of a friendly and encouraging audience.

A third big social affair, the annual election party, is held in mid-February when the club's officers are selected in an atmosphere of gayety and music. The club has its own orchestra which plays voluntarily and expense-free at these functions.

A sensible, well rounded athletic and recreational program provides something of interest to all from cards, table tennis and pocket billiards, all club room activities, to bowling, softball and basketball. In the latter sports, the club provides uniforms, some equipment and pays league entrance fees. Six bowling teams are sponsored and Bill Davies draws evidence from the way the team uniforms are handled to prove his theory that people behave better when left to their own resources. Mr. Davies has found that were the uniforms to be donated to the teams by the company, new uniforms would be needed every year, but with the club members buying the uniforms with their own club money, every uniform invariably is returned in A1 condition needing cleaning only.

Raymond Dillon and Ralph Allen, members of the exclusively male Thatcher Men's Club, playing a fast game of table tennis.

The club's literary activities consist mainly of the mimeographed weekly publication, the Cullet Box, containing the usual personals including of course new members of the Stork Club with the name of the proud father. A similar paper is published by the Streator, Ill. plant of the company which has its own club, functioning along the same lines as the Elmira club. Here, too, the paternal, guiding hand of Bill Davies has been largely responsible for its fine record of successful cooperation and activity.

Although officially listed as Personnel Counsel of the Thatcher Glass Manufacturing Company, Bill Davies in his capacity of Secretary-Treasurer of the Thatcher Men's Club spends some time every day on club work. He attends all club meetings which are held on the employees' own time. With his unusually intimate contact with the company's

(*Continued on page* 226)

CUSTOMS COURT DECISION LOWERS TARIFF ON SEMI-AUTOMATIC WARE

The U. S. Court of Customs and Patent Appeals ruled on March 22 that glass bottles made with hand-fed equipment in England are properly classed as "produced by automatic machine" and are therefore dutiable at 25 per cent ad valorem rather than at 75 per cent—the rate on ware "otherwise produced." The decision reversed a prior ruling by the U. S. Customs Court in New York by a 3-2 vote. If not appealed to the U. S. Supreme Court, the majority opinion by Judge Ambrose O'Connell will settle some 44 similar protests against the 75 per cent rate on British made toilet and perfumery ware. The case is one of the hardest fought customs litigations of recent years.

The applicable provision of the Tariff Act of 1930 reads as follows:

"218 * * * (e) Bottles and jars, wholly or in chief value of glass, of the character used, or designed to be used as containers of perfume, talcum powder, toilet water or other toilet preparations; bottles, vials and jars, wholly or in chief value of glass, fitted with or designed for use with ground glass stoppers, when suitable for use and of the character ordinarily employed for the holding or transportation of merchandise; all the foregoing produced by automatic machine, 25 per centum ad valorem; otherwise produced, 75 per centum ad valorem. For the purposes of this subparagraph no regard shall be had to the method of manufacture of the stoppers or covers."

The protesting firm in the case which went to trial was the Griffon Importing Co. Testimony given by affidavit of the British manufacturer was to the effect that the bottles were made by a 3-man team, with one man using a gathering iron and the other two employed in hand operation of the parison and finishing molds, the blowing being done with compressed air. Human lung power was not used at any time.

Testimony by Charles B. Garwood, factory superintendent employed by Carr-Lowrey Glass Co., Baltimore, for over 50 years, showed the similarity of the process to methods employed in the U. S. during the early 1920's when mechanical equipment was being used for the first time in the production of toiletry ware. As equipment became more automatic, the number of operators was reduced—first to two—then one, and finally fully automatic equipment became available.

Judge O'Connell noted that an earlier case which raised the same issue had involved a one-man machine, employed in Czechoslovakia. He said that in that case (Jos. Reidel Glass Works, Inc. v. U. S.) the molten glass was fed by hand but the court held that the machine which actually produced the bottles was automatic in its entire operation. He said the correctness of the earlier decision had not been challenged by the parties in the Griffon case, although it was fully apparent that the machine involved was not *fully* automatic. The Reidel decision, he said, held that on the facts presented, and in view of the legislative history of which the court took judicial notice, the machine was automatic.

Judge O'Connell said the Reidel decision did not, as the Govt. attorneys contended, judicially determine the meaning of "automatic" for application in all future cases until a new Congressional mandate. He said it was evident from the number of cases cited that "automatic" has different meanings under different circumstances, and the Court "must be guided in reaching its conclusion by the intent which the Congress had in mind when it made use of the term in enactment of the statute."

Going back to the hearings in the 70th Congress (1929) Judge O'Connell quoted testimony by the late Mr. Leach of Carr-Lowrey to support the need of protection for U. S. hand made perfume ware against import competition. Originally the tariff bill applied a rate of 70 per cent to all imported bottles, regardless of the method of manufacture. The previous rate had been 55 per cent. The Senate amended the bill to provide separate rates for bottles produced by machine, with the higher rate for hand made ware "in order to perpetuate an industry which is practically the only source of employment for the comparatively few highly skilled glass bottle blowers remaining in the trade." The 75-25 distinction was suggested by the late Senator Copeland of New York, who said he wanted to protect the bottle blowers of New Jersey and Maryland and that if the rate on machine made ware was too high it would stimulate the importation of hand made ware. Nowhere in the debate, said Judge O'Connell, was there any reference to fully automatic vs. semi-automatic machinery.

"Obviously," he said, "there would have been no sense in fixing one rate of duty for imported bottles produced by fully automatic machines and a rate three times as high on bottles produced by the semi-automatic machine, *since the highly skilled American glass blower and the product of his labor were nowise involved in competition with the product of either class of machine.* (Emphasis by the Court.) Moreover, had the Congress intended to impose a higher rate of duty on bottles produced by the semi-automatic machine, it would have been quite a simple matter for it to have said so.

"The bottles submitted at the trial of the instant case represent no such quality of merchandise as that produced by the American glass blower, but are of the cheaper variety produced by automatic or semi-automatic machine. No highly skilled glass blower was employed in the production of the bottles, and only ordinary labor, outside of the gatherer who fed the gob from the forehearth, as in the Reidel case, was employed in the production of the imported merchandise. Therefore it is our opinion that the involved bottles were produced by 'automatic machine' within the purview of the statute and were entitled to be assessed with duty at the rate of 25 per centum ad valorem as therein provided."

In a special concurring opinion, Judge Charles S. Hatfield said it was clear that Congress did not intend "to provide a 75 per centum ad valorem duty on bottles produced by a hand-operated machine which does not involve the skill and labor of the highly skilled glass blower in order to protect the manufacture of bottles produced by fully automatic machines."

(*Continued on page* 222)

SPRING MEETING OF THE OPTICAL SOCIETY

There was little activity on glass and related subjects reported at the 1949 Spring Meeting of the Optical Society of America. It will suffice to indicate trends of general interest. The prevailing trends were emphasized by the organization of symposia of specific scope.

The Symposium on ultra-violet microscopy was introduced by the spectacular demonstration of the instrument called the Color Translating UV Microscope by E. H. Land, of the Polaroid Corporation. The resolution of UV microscopes is about twice that of the ordinary microscope. Additional contrast is provided by the conversion of images embracing the entire range of visible color. This is done by the cooperative use of color filters, photography, and automatical photodevelopment. Since the performance takes less than one minute, the observer has the illusion of seeing an object in the uv microscope in full color, each hue representing a certain domain in uv. If uv "colors" of substances are known, the translated colors can be used for semiquantitative analysis by vision of proportions from prepared charts. The Symposium described details of optics, photography, microscopy and biological application.

Spectroscopy, as always, remains of general interest to our sciences. Professor G. R. Harrison of M.I.T., in an invited paper, reviewed the history and the limitations of large gratings and proposed a new solution intermediate between grating and echelon, which he named echelle. This device possesses the high resolution of gratings but requires a much smaller amount of rulings, though of controlled profile. Emission spectography and spectrophotometry gained in consideration because of its application to luminescence. Automatic spectroradiometers find increasing attention.

A full day symposium was devoted to luminescence. The focus of attention was the work of F. Urbach and his collaborators (Eastman Kodak) on the stimulation of luminescence by infra-red. This branch of science has had spectacular applications to the "snooperscope" and related devices seeing at night and at distances.

Color remains of particular interest to glass scientists. A new integrator attachable to the GE Hardy Spectrophotometer is the result of the cooperation of General Aniline and General Electric Workers (Davidson, Godlove and Imm). The instrument was demonstrated and numerous samples were measured within minutes by visitors. Various presentations correlated empirical color systems with Munsell and ICI standards, the biological group showing growing interest. R. Bingham, of Ansco, described the quantitative requirements of daylight conversion filters in photography. Granville of the Container Corporation and D. B. Judd of the National Bureau of Standards studied the phenomenon of apparent variation of equal colors having different spectrophotometric characteristics with distance from the eye. Many other phenomena of vision were the subject of another symposium.

Among subjects on general optics, glass people are most interested in mirrors and films. The group at Ft. Belvoir (Hass, Benson, Scott) is most active and has improved oxide films on aluminum mirrors by anodic oxidation in electrolytic baths. The 72" evaporation units used in producing aluminum mirrors with silicon monoxide films were described. P. Leurgans, of Bausch and Lomb, extended the theory of evaporated antireflection films. It now appears that many filters of the Dennison-Hadley or A. F. Turner frustrated total reflection type can be designed for preselected characteristics.

INTER-SOCIETY COLOR COUNCIL

The Council held its annual meeting on March 9, 1949, which was as usual the day before the Optical Society Convention. The Council admitted four national societies and so increased its corporate membership to nineteen. The American Ceramic Society was represented by its Delegation, under the Chairmanship of Dr. Richard Hunter, noted color instrument designer. Some of the activities were of interest to color workers in the glass industry.

Two Committees reported major jobs accomplished after work extending over several years. Sidney M. Newhall, Eastman Kodak color expert, and his Committee submitted a dictionary of color terms, which refers terms and definitions to societies using them. Mrs. Josephine G. Brennan, who has left Eastman Kodak to join the Fort Belvoir group, was active in this useful compilation. Contrasting word usages for the same thing as well as contrasting definitions for the same word are shown and cross-references given. The work is a guide through the existing confusion as well as the first step of organized and perhaps unified terminology.

Dr. Deane B. Judd, color expert of the National Bureau of Standards, and his Committee have completed the revision of the 1939 NBS report on color names as organized in a system known as the ISCC-NBS Method of Color Designation.[1] The system uses combinations of up to four very few simple English words to describe precisely defined color ranges. The limits of each definition are defined in Munsell terms. A defined area of greens, for instance, is described by "very light yellowish green"; another by "very pale yellowish pink," etc.

The color terms list will be distributed by the Inter-Society Color Council to persons interested (at two dollars to non-delegates or members) and the color names revision will be published by the National Bureau of Standards.

The American Ceramic Society Delegation is planning an open meeting to be scheduled at the Cincinnati Convention.

[1] D. B. Judd and K. L. Kelly, Method of Designating Colors, J. Research NBS, 23, 355 (1939).

• At the annual meeting of the Monorail Manufacturers' Association held in Chicago, A. F. Anjeskey, Sales Manager of the Cleveland Tramrail Division of the Cleveland Crane & Engineering Company, was elected President.

• Arthur E. Stoddard has been elected a Director and President of the Union Pacific Railroad, according to an announcement made by E. Roland Harriman, Chairman of the Board.

INVENTIONS AND INVENTORS

A Summary of Recently Issued Patents of Interest to the Glass Industry

Miscellaneous Processes

Owens-Illinois Ware Conveyor. Fig. 1. Patent No. 2,461,277. This is an invention by John Hohl, Robert K. Belknap, Jr. and Herbert A. Barnby who assigned the invention to Owens-Illinois Glass Company. The invention shows a machine for taking glass jars from shipping containers, washing, preheating and delivering them while hot to a filling machine.

The apparatus comprises frame bars 10 and 11 supported on standards 8 having adjustable feet 9. A worm conveyor 12 advances the jars 17 as they are received from a belt conveyor 21 which is driven by a motor 23. The jars are guided to the worm conveyor by belts 26 which pass over pulleys 27. The jars are washed by water from spray nozzles 51 while they are right side up and then they are inverted and washed again by upwardly directed spray nozzles. The washing mechanism is enclosed by a casing 56 and 57 and the waste water is carried away by a discharge pipe 61.

The arrangement is such that the jars are thoroughly washed, preheated and delivered to a conveyor which takes them to the filling machine.

The following references are of record in the file of this patent: United States Patents: 450,018, Hopcraft, Apr. 7, 1891; 643,001, Overton, Feb. 6, 1900; 703,190, Geurink, June 24, 1902; 931,434, Krummel et al., Aug. 17, 1909; 1,423,693, Thurston, July 25, 1922; 1,608,499, Fuller, Nov. 30, 1926; 1,621,611, Thompson, Mar. 22, 1927; 1,850,067, Ayars, Mar. 22, 1932; 2,259,748, Hullhorst, Oct. 21, 1941; 2,284,286, Krueger, May 26, 1942; and 2,336,606, Everett, Dec. 14, 1943.

Bottle Decorating Machine. Fig. 2. Patent No. 2,461,281. Albert S. Jackson, Wood River, and Clarence A. Heyne, Alton, Ill., assigned this invention to Owens-Illinois Glass Company. The machine applies through a screen to one or more sides of any bottle having flat sides, such as squares and panels. The particular construction shown applies decorations to four sides of a square bottle.

The machine comprises an intermittently rotating carriage 17 which carries five work-holding heads 18 each supporting a bottle B so that it can be turned about its vertical axis to present the four sides to the decorating means. The operator sets the bottle in the head at station 1 and as the carriage 17 turns, the four sides of the bottle are presented successively to decorating stations

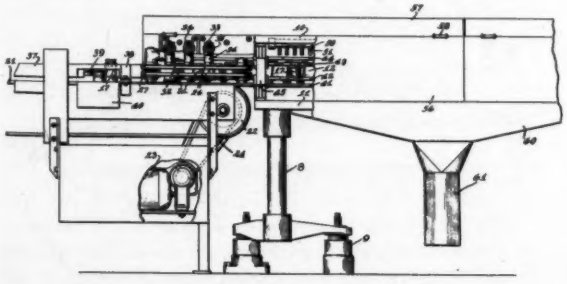


Fig. 1. Owens-Illinois Ware Conveyor.

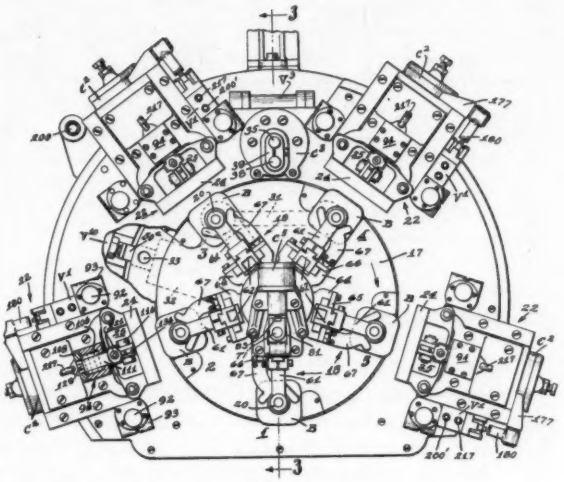


Fig. 2. Bottle Decorating Machine.

2, 3, 4 and 5 where there are fixed decorating units 22.

Each of these units includes a frame 24 carrying a screen and squeegee, all being mounted on a carrier 25 which is movable toward and from the bottle. Automatic means is provided for all movements and also to stop the decorating process in case there is no bottle in the head presented. The decorated bottle is removed at station 1 and another inserted in the head.

The following references are of record in the file of this patent: United States Patents: 1,904,332, Sidebotham, Apr. 18, 1933; 2,142,158, Sloan, Jan. 3, 1939; 2,229,346, Shurley, Jan. 21, 1941; 2,231,553, Soubier, Feb. 11, 1941; 2,307,404, Heyne, Jan. 5, 1943; and 2,383,947, Wensel, Sept. 4, 1945.

Method of Making Glass-Metal Seals. Fig. 3. Patent No. 2,462,205. This method was invented by Raymond R. Machlett, New Canaan, and Gottfrid W. Steen, Stamford, Conn., who assigned it to Machlett Laboratories, Incorporated of Springdale, Conn. The joint made by this method is mechanically strong and will withstand a high vacuum.

The particular embodiment of the invention shown in the figure is adapted for the manufacture of an insulating structure 20 which is disclosed in Patent No. 2,376,439. This is made up of a plurality of alternate glass sections and metal discs which may well be made of the alloy known as "Kovar." "Pyrex" is recommended for the glass. A glass section is sealed to opposite faces of each disc.

The machine comprises a column 26 having near the top, an adjustable support 28 and below that, an annealing oven 29 supported by a bracket 30. Another bracket, also vertically adjustable, carries a sleeve 37 splined on a shaft of 38 which is rotated slowly by a motor. This shaft carries a series of projection spaces in accordance with the desired distance between the discs in the finished product.

A group of burners 50 are adjustably mounted and

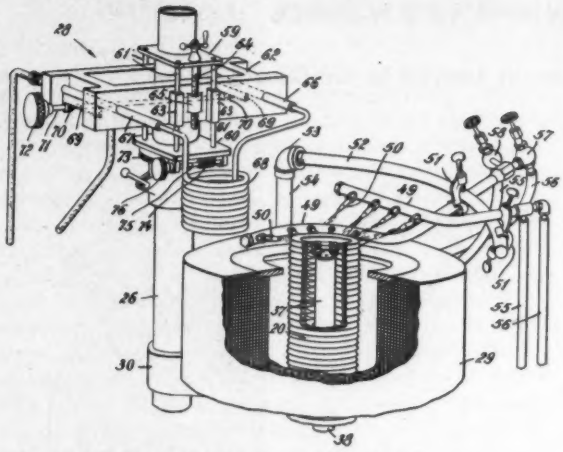


Fig. 3. Method of Making Glass-Metal Seals.

provided with the usual controls. Operation is started by beginning the building of a stack of alternate discs and glass sections on the shaft 38 spaced apart by the supports slightly more than desired in the finished product. The heat is then turned on and the pile gradually settles until the discs contact with the supports. At the proper time, the gas fire is cut off and a high frequency coil 68 is brought into operation.

The cylinder, thus gradually built up, heated, manipulated by hand and then annealed, has many advantages over prior products of this character.

The following references are of record in the file of this patent: United States Patents: 1,740,443, Donat, Dec. 24, 1929; 1,995,803, Gilbert, Mar. 26, 1935; 2,048,-556, McArthur, July 21, 1936; 2,125,316, Ronci, Aug. 2, 1938; 2,167,431, Bowie, July 25, 1939; 2,297,492, Michaelis, Sept. 29, 1942; 2,345,278, Monack, Mar. 28, 1944; and 2,376,439, Machlett et al., May 22, 1945.

Hartford-Empire Non-Refillable Bottle. Fig. 4. Patent No. 2,462,988. This invention was assigned to the Hartford-Empire Company by Charles E. Mongan, Jr. The invention consists of a glass bottle having a glass closure fused or welded onto it and so tempered that a strain exists near the weld, which can be cracked off by scratching the surface.

As shown in Fig. 4, a bottle B has a flange removed from the mouth of the bottle to which a cap C has been welded at W. The cap has been treated by appropriate heating and cooling so that a strain exists at 22 near the top of the annealing ring 24 which is the final step in the method. It will be seen that any glass fragments resulting from cracking off the closure will be prevented from entering the bottle by the extended neck 26.

This method provides an all-glass container which cannot be re-used after once opening. The patent shows the various steps in tempering and welding the bottle cap into place as a modification of the apparatus.

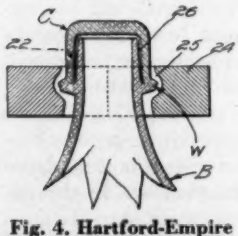
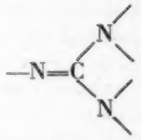


Fig. 4. Hartford-Empire Non-refillable Bottle.

The following references are of record in the file of this patent: United States Patents: 562,-243, Riley, June 16, 1896; 573,-760, Bultman, Dec. 22, 1896; 1,024,917, Trexler, Apr. 30, 1912; 1,190,708, Bennett, July 11, 1916; 1,475,908, Walsh, Nov. 27, 1923; 1,713,854, Meyer, May 21, 1929; 2,009,738, Kuenstler, July 30, 1935; 2,177,324, Long, Oct. 24, 1939; 2,177,336, Shaver et al., Oct. 24, 1939; 2,244,715, Long, June 10, 1941; 2,269,060, Mitford, Jan. 6, 1942; 2,285,595, Littleton et al., June 9, 1942; and 2,296,579, Seelan, Sept. 22, 1942. Foreign Patents: 536,-858, Great Britain, May 29, 1941 and 323,394, Italy, Dec. 19, 1934.

Glass Wool and Fibers

Process of Dyeing Glass Fibers. Patent No. 2,462,428. This is the invention of Hans Roesti of Basel, Switzerland, who assigned it to Ciba Limited located in the same place. It has long been known that the dyeing of glass fibers and similar substances has never been satisfactory. This inventor has discovered that soluble products produced by the interaction of formaldehyde and compounds which contain at least once the atom grouping



are not of cyclic character and which consist of elements the atomic weight of which is not greater than 16 and which contain in their molecule in relation to carbon less oxygen than urea, for example transformation products of cyanamide, such as dicyandiamide or dicyandiamidine or guanidine, possess the characteristic property of precipitating onto fibrous materials having as such no affinity for dyestuffs, thus imparting to the treated material a remarkable affinity for water-soluble organic dyestuffs.

The patent gives several examples of the process, one of which is as follows: A fabric consisting of glass or Vinyon fiber is treated for ¼ hour at room temperature in a solution containing for 1000 parts of water 10 parts of a water-soluble product produced by the interaction of formaldehyde and dicyandiamidine and 1 part of ammonia, and after drying introduced into an aqueous solution of 0.5 per cent strength of Benzyl Violet 5BN (Color Index No. 698) at 75 or 50° C. and dyed for 5 minutes. The material is then rinsed in cold water until the washing water is entirely clear. An intensive violet dyeing is obtained.

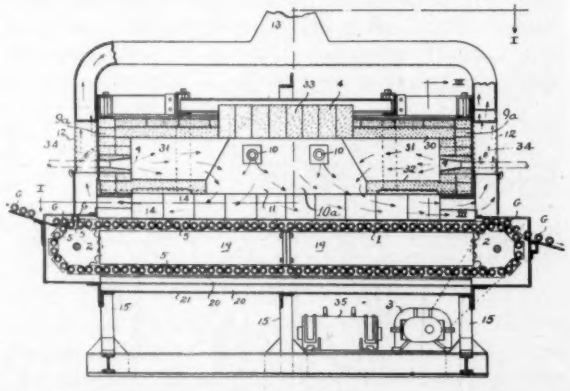


Fig. 5. Tube Straightening Machine.

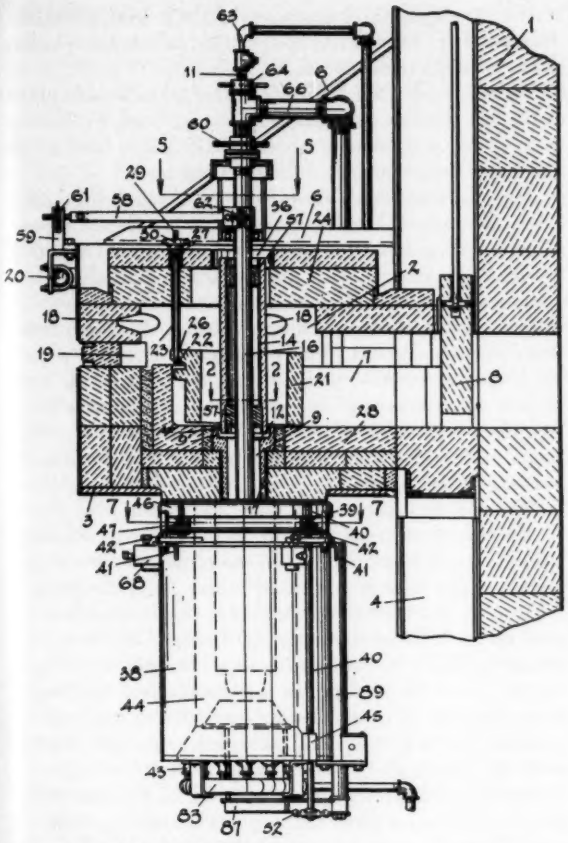


Fig. 6. Patent No. 2,462,805.

After treating with the reaction product from formaldehyde, the material can also be rinsed and introduced in the dyebath without previous drying.

The water-soluble product produced by the interaction of formaldehyde and dicyandiamidine has been dissolved according to the following prescription:

Four parts of the product were introduced into 4 parts of water of 35° C., while stirring, a thick paste being thus obtained. 16 parts of water of 35° C. containing 0.12 part of formic acid were added to this paste. The water-soluble product produced by the interaction of formaldehyde and dicyandiamidine can be prepared by allowing formaldehyde to act on dicyandiamidine in an alkaline medium.

The following references are of record in the file of this patent: United States Patents: 2,119,189, Widmer, May 31, 1938; 2,169,546, Widmer, Aug. 15, 1939; 2,189,-918, Moncrieff, Feb. 13, 1940; 2,257,076, Petke, Sept. 23, 1941; 2,315,329, Hood, Mar. 30, 1943; and 2,317,-965, Bestian, Apr. 27, 1943. Foreign Patents: 509,408, Great Britain, July 11, 1939; 559,329, Great Britain, Feb. 15, 1944; and 768,282, France, May 14, 1934.

Tube and Cane Machines

Tube Straightening Machine. Fig. 5. Patent No. 2,463,650. This invention was assigned to Glafent Corporation, a corporation of Maryland, by Harold H. Snyder, Mt. Lebanon, and Samuel A. Forter, Avalon, Pa. The machine is described for use on glass tubes and rods but it may equally well be used in connection with any material which can be softened by heat.

Reference is made to certain patents owned by the same assignee: Patent No. 2,402,924 which shows a machine for continuously shaping glass tube or rod and Patent No. 2,306,721 which shows a machine for cutting the rod or tubing into the desired lengths. After the tubes have been made and cut by these machines or similar ones, it is still necessary to straighten the tubes slightly before they are ready for the market. That is done by the present invention which supports the tube on a pair of rotating rolls while it is gradually heated to the softening point and then cools it so as to preserve the true shape imparted while it was hot.

Fig. 5 is a section taken lengthwise through the machine which comprises an endless conveyor 1 mounted on sprockets 2 driven by a motor 3 and running through a furnace 4. The conveyor is composed of rolls 5 which rotate in bearings at both ends, carried by the chains which are driven by the sprockets 2. The tubes G are fed into the machine at the left of the figure where they rest on two adjacent rolls which keep the tube turning as long as pinions on the end of the roll shaft are in mesh with a rack.

The furnace 4 comprises a refractory box which is heated by burners 9 and 10. The products of combustion are carried away from each end by conductors 12 connected to a stack by a passageway 13. Dampers 34 regulate the exhaust of gas from the furnace and the construction is such that the greatest heat is at the middle of the furnace and the temperature decreases in both directions. In this way the tubes are gradually heated from room temperature to the softening point at which time the rolling motion removes any slight curvature that there may be in the tube. It is then gradually cooled so that it may be taken off the conveyor at the right, again at or near room temperature.

The following references are of record in the file of this patent: United States Patents: 565,576, Smith, Aug. 11, 1896; 1,181,771, Kauffeld, May 2, 1916; 1,473,675, Halversen, Nov. 13, 1923; 1,526,583, Beasley, Feb. 17, 1925; 1,696,900, Baily, Jan. 1, 1929; 1,748,473, Fisk, Feb. 25, 1930; 1,872,062, Burke, Aug. 16, 1932; 1,881,-267, Drexler, Oct. 4, 1932; 1,944,217, Carpenter et al., Jan. 23, 1934; 2,058,171, Morton, Oct. 20, 1936; 2,120,-912, Slocombe, June 14, 1938; 2,323,214, Gardner, June 29, 1943; and 2,351,262, Hahn, June 13, 1944. Foreign Patent: 433,078, Germany, Apr. 13, 1927.

Danner Tube Drawing Patents. Five patents were issued to Edward Danner on Feb. 22, 1949, all relating to the manufacture of glass tube or cane. *Fig. 6. Patent No. 2,462,805.* This patent relates particularly to the forebay (forehearth) from which the glass is delivered which may be used to produce tubing from a plurality of different glasses.

As shown in the figure, a furnace 1 delivers glass to a forebay 2 having a trough 7 controlled by a gate 8. An outlet 9 is provided to deliver the glass to the shaping element below.

In the manufacture of tubing, air comes from the blow pipe 11 and the shaped tube is cooled by air from a pipe 16. A sleeve 14 surrounds the pipe 16 and also surrounds the upper end of the outlet 9 so that the glass flows over the shoulder 12 to form a hollow cylinder. The forebay is heated by fire through the ports 18.

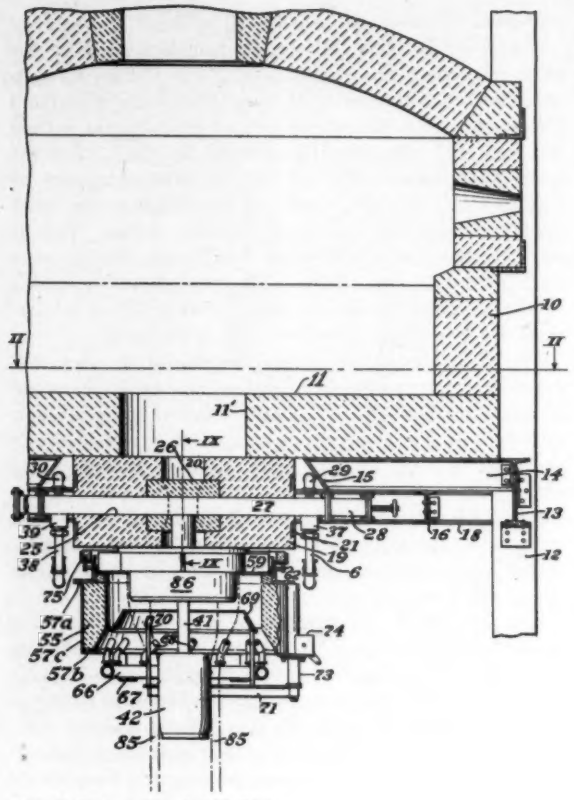


Fig. 7. Patent No. 2,462,806.

A feed distributor 21 has lugs 22 arranged so that the distributor may be adjusted vertically to regulate the rate of flow of the glass. Below this there is a glass-forming device 38 supported by the frame 3 of the forebay and is vertically adjustable to provide for the exhaust of gas produced by the burners 43. A handle 52 is connected to raise or lower the damper ring. A shell 44 is adjustably mounted and the flow of glass may be regulated by adjustment of the distributor 21 and/or of the sleeve 14. Burners 43 are mounted on a circular pipe 83 below the glass-forming device 38 so that the temperature of the issuing glass may be controlled.

Many adjustments are provided so that tubing of the desired diameter and wall thickness can be produced. A tube may thus be formed from glasses of two or more distinctive characteristics. Several modifications are shown in the patent which should be studied by those interested.

The following references are of record in the file of this patent: United States Patents: 1,239,024, Manning, Sept. 4, 1917; 1,571,216, Soubier, Feb. 2, 1926; 1,612,419, Danner, Dec. 28, 1926; 1,653,848, Grotta, Dec. 27, 1927; 1,892,477, Weber, Dec. 27, 1932; 1,920,366, De Silva, Aug. 1, 1933; 1,926,410, Soubier, Sept. 12, 1933; 1,933,341, Richardson, Oct. 31, 1933; 1,949,037, Cardot, Feb. 27, 1934; 1,963,910, McIntyre et al., June 19, 1934; 1,975,737, Sanchez-Vello, Oct. 2, 1934; 2,006,947, Ferguson, July 2, 1935; 2,009,326, Sanchez-Vello, July 23, 1935; 2,009,793, Sanchez-Vello, July 30, 1935; 2,052,269, Woods, Aug. 25, 1936; 2,085,245, Woods, June 29, 1937; 2,131,417, Danner, Sept. 27, 1938; 2,150,017, Barnard, Mar. 7, 1939; 2,226,498, Koob, Dec. 24, 1940; 2,251,727, Wellech et al., Aug. 5, 1941; and 2,390,925, Danner, Dec. 11, 1945. Foreign Patents: 38,432, France, Mar. 3, 1931. (Addition to No. 693,153).

Fig. 7. Patent No. 2,462,806. This is the second in the series of Danner tube drawing patents and it shows a tube drawing apparatus in which all of the mechanism is located below the bottom of the forehearth.

The figure shows a vertical section through the orifice 11′ in the bottom 11 of the forehearth 10. Beams 14 support a frusto-conical ring 15 surrounding a refractory block 19 in contact with the forehearth bottom 11 and having a central opening 20 aligned with the opening 11′. A passageway 25 extends through the block 19 and intersects the opening 20. The passageway encloses a tube 27 having removable ends 28 and the part of the tube within the opening 20 is covered by a protective mass of refractory material 26. Air is supplied to the tube from a pipe 29 at one end and at the other there is an outlet pipe 30.

Water is admitted to the tube 27 from a pipe 6 and is discharged through a pipe 38. A pipe 41 depends through the hole 20 and at its lower end carries a sizing mandrel 42. This is cooled by water from the pipe 6. A forming chamber 55 is suspended below the block 19 and the general construction is the same as shown in Danner's Patent No. 2,462,805 abstracted above. A fuel-supply manifold 86 supplies the needed heat and means is provided so that the deflector ring 69 may be raised or lowered. A ring damper is provided to control the upward draft through the chamber 55.

Several modifications are described in the patent but they all provide a glass shaping mechanism in which no part passes through the molten glass and a tube 85 uniform in size is rapidly produced.

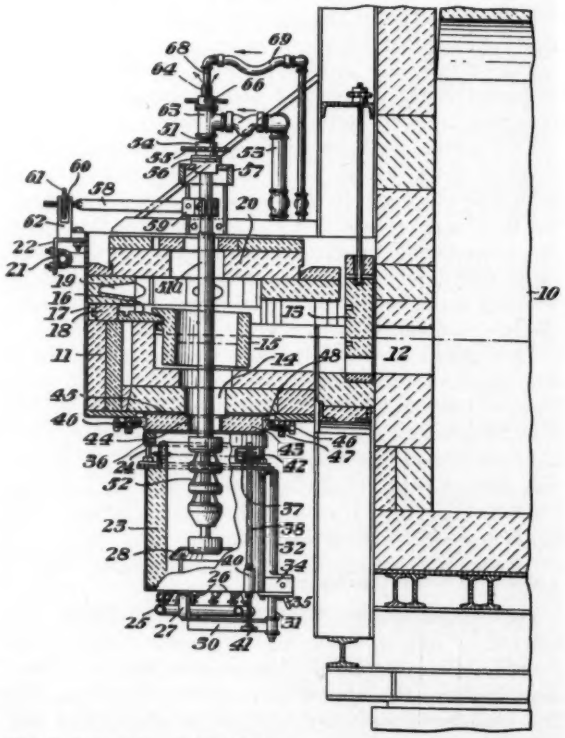


Fig. 8. Patent No. 2,462,807.

The following references are of record in the file of this patent: United States Patents: 1,507,852, Pleukharp et al., Sept. 9, 1924; 1,673,907, Ferngren, June 19, 1928; and 2,131,417, Danner, Sept. 27, 1938. Foreign Patents: 381,582, Great Britain, Sept. 29, 1932 and 543,172, Great Britain, Feb. 12, 1942.

Fig. 8. Patent No. 2,462,807. This patent is characterized by a shaping mandrel over which the glass flows in the form of a series of spaced rings. These rings do not have to be separate members as the same effect may be obtained by the use of a helix.

The drawing shows a longitudinal section through a forehearth having the new tube drawing machine installed. A glass melting tank 10 has a forehearth 11 connected with the tank by a passage 12, the effective size of which is controlled by a gate 13 so that the amount of glass flowing to the outlet 14 can be regulated.

Just above the outlet 14 there is a cylindrical gate 15 which may be adjusted vertically by wedges 16. Burner ports 19 are supplied with fuel from the manifold 21.

Below the forehearth there is a forming chamber 23 which may be the same as described in some other Danner applications. This chamber is suspended by bars 24 and it is heated by burners 26 connected to a manifold 25. A crank 35 serves to raise and lower a deflector 28 for controlling the heating. A damper 36 is arranged to be adjusted vertically by a hand wheel 41.

The flow of molten glass is regulated by a refractory disc 43 having a metal bushing 44. A vertical pipe 51 is connected to an air pipe 53 for cooling purposes. This pipe may be adjusted vertically by a hand wheel 55. Various other adjustments are provided. The shaping element shown at 52 comprises a number of rings which gradually form the glass into cylindrical shape. Several modifications are described in the patent which is a continuation-in-part of two prior applications.

The following references are of record in the file of this patent: United States Patents: 1,653,848, Grotta, Dec. 27, 1927; 1,766,638, Howard, June 24, 1930; 1,873,685, Voss et al., Aug. 23, 1932; 2,133,662, Gray, Oct. 18, 1938; and 2,212,448, Modigliani, Aug. 20, 1940. Foreign Patents: 38,432, France, Mar. 3, 1931 and 428,421, Great Britain, May 13, 1935.

Fig. 9. Patent No. 2,462,808. This patent shows a machine for the manufacture of spiral tubes which has heretofore been done by reheating and bending a straight tube. This was not only expensive but the quality of the product, particularly in the larger sizes, was not always good. One important use for spiral tubing is in the manufacture of fluorescent lights.

The glass from a melting tank passes to a forehearth 2 having an outlet 3 above which there is a distributor 4 which may be as shown in Danner's Patent No. 2,390,925. The glass passes downwardly to a shaping element 12, the construction of which does not form any part of this invention, one construction being shown by way of example. A water cooled shield 33 encloses the downwardly flowing tube of glass shown in dotted lines. Pipes 42 and 43 supply fuel or cooling air as may be needed.

The preliminary formed tube then goes to a curved sizing chamber formed by the lower end of a tube 61 located inside of a blow pipe 18. Appropriate cooling means are provided where needed and the tube may be

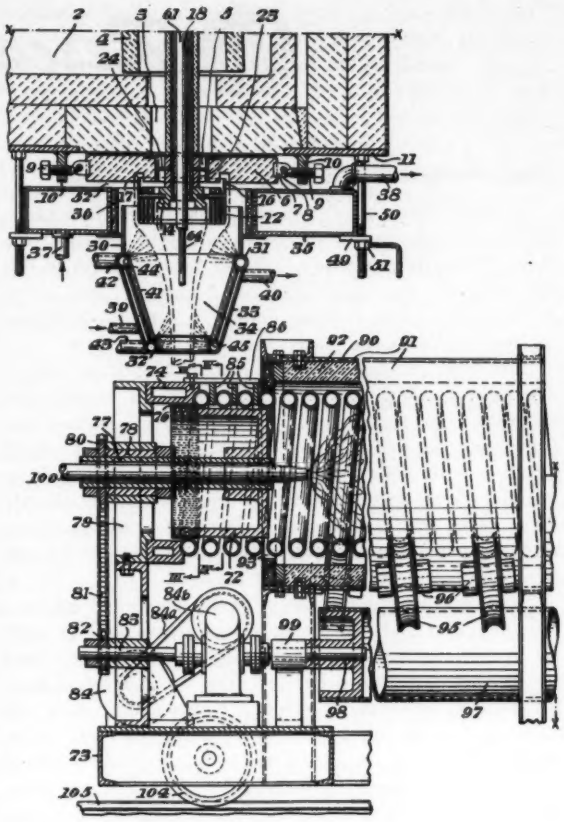


Fig. 9. Patent No. 2,462,808.

reheated before it is given its spiral shape. The tube is wound onto a drum 72 to which it is guided by helical grooves and cam 74. The drum is mounted on a hollow shaft 77 which is driven through connections to a motor 84.

This mechanism causes the tube to wind spirally and in order to preserve this shape, the tube passes between spacing bars 85 although the tube may be close-wound by another device shown in the patent. As the tube leaves the drum 72, it passes into a lehr 90 where it is supported and advanced by inclined rolls 95 frictionally driven by a shell 97 actuated by a motor 84. Heat for annealing is supplied by the tube 100 so that when the tube leaves the lehr it is properly annealed and is ready to be cut into the desired pieces.

The following references are of record in the file of this patent: United States Patents: 1,750,971, Soubier, Mar. 18, 1930; 1,926,905, Le Coultre, Sept. 12, 1933; 2,296,321, Wellech, Sept. 22, 1942; 2,390,925, Danner, Dec. 11, 1945; and 2,396,254, Everett, Mar. 12, 1946.

Fig. 10. Patent No. 2,464,028. This patent is a continuation-in-part of the application resulting in Patent No. 2,420,934 dated May 20, 1947. The invention is particularly adapted to the manufacture of tubing having a solid cylindrical wall but it is also adapted to the manufacture of tubing made of cellular glass and to tubing having a non-cylindrical cross section. Heretofore, it has been difficult to make heavy walled tubing without showing drawing lines and the manufacture has been slow and expensive.

(*Continued on page* 230)

GJ Research Digest

Temperatures in the Open-hearth Furnace

In *Metals Technology*, August 1948, Robert B. Sosman discusses temperatures in the open-hearth furnace (the Howe Memorial Lecture). While the majority of this discussion is concerned with steel-making, parts of it apply to the glass furnace field. It is this part of the discussion that is condensed below:

"Producer gas has so nearly disappeared from today's steelmaking plant that the two separate regenerator chambers, one for preheating the producer gas and one for preheating air, are now either replaced by a single chamber with a single arched roof, or they are used in parallel, both accessible to the same waste gas or air flow. This feature of the design does not, however, assure that the temperature will be distributed in accordance with the symmetry of the chambers.

"Each regenerator chamber, for constructional reasons, is rectangular. The heat-absorbing checkerwork is built up of brick in a variety of designs, the entire mass resting upon a series of rider walls that form a set of flues beneath the checkerwork, while a clear head-room is left above it. At an infinitesimally slow rate of flow, either gas or air should distribute itself uniformly through all the vertical passages of the checkerwork, and the temperature over any horizontal plane should be uniform, though changing continuously with time. Actual conditions of flow lead to unsymmetrical distribution of gas or air and consequent unsymmetrical isothermal surfaces. The dissymmetry changes gradually as dust collects and clogs the passages that have been carrying the largest volume. Temperature distribution in the checkerwork is therefore extremely complex, undergoing cycles as follows: 1) the gas and air cycle, 10 to 20 min. long; 2) the furnace cycle, 4 to 12 hr. long; 3) the cleaning or dust-blowing cycle, 1 to 30 days long.

"Pyrometry of the checkerwork is primarily for protection, secondarily as a control for efficient reversal of the furnace. Reversal may be either by automatic control, or manually on a signal given by the pyrometers.

"Protection is necessary because fireclay brick is almost universally used for the checkerwork, and such brick begins to soften and deform at a temperature which may be as low as 1175°C or as high as 1480°C depending upon the quality of the brick, but is in all cases lower than the temperature of about 1550°C which is easily attained if the furnace gases are allowed to flow uninterruptedly through one regenerator chamber. The iron oxide dust, furthermore, reacts with fireclay to form a liquid at a temperature as low as 1075°C. There must be some assurance, therefore, that the furnace is reversed before the hottest part of the checkerwork becomes overheated and damaged.

"Obviously, the right temperature to measure for the sake of protecting the checkers is the temperature of this hottest spot. This is also the temperature best suited to control reversals, because of its sensitive response to changing conditions in the furnace. As a rule, the highest temperature is attained by the top course of bricks on that part of the checkerwork that is nearest the furnace. Larsen and Shenk found that this temperature can be satisfactorily measured by either a photoelectric (Photronic) pyrometer or a total radiation pyrometer, sighted across the top of the checkers from the bulkhead of the regenerator chamber. The pyrometer can also be sighted through a side wall of the chamber.

"The maximum at the hottest point in the checkerwork is usually about 1000°C (1800°F). 1300°C (2400°F) is occasionally found and can perhaps be endured for a campaign, particularly if the upper courses are of high-heat-duty or super-duty fireclay brick. The hottest that we have observed in a furnace with silica roof is about 1375°C. In an all-basic furnace, burning more fuel and delivering gases for at least a part of the time at a higher temperature than the silica furnace, the top checker brick have reached 1450°C. Such a temperature calls for either silica or basic brick for the top courses.

"The minimum top temperature with efficient operation may be as low as 800°C. A minimum of 750°C has been observed.

"The usual range of the instrumental temperature scale for the hottest part of the checkerwork, as set up in an automatic reversal mechanism of Larsen and Shenk's design, is 650-1400°C or 1200-2600°F.

"It is worth noting that a high temperature in the regenerators is not synonymous with efficient operation of the furnace; the optimum for a given furnace, so far as utilization of the heat is concerned, may be an intermediate, rather than a high maximum.

"Automatic reversal of the furnace can be based on various functions of temperature, time and temperature difference. This is a large subject in itself, which can only be mentioned in passing, with the further remark that the temperature on which it is based can also be, and frequently is, measured by means of base-metal thermocouples in various places in the chamber. The disadvantages of the thermocouple in this service are 1) that it cannot be used economically at the hottest part of the checkerwork, and 2) that it reads a compromise temperature which is influenced partly by the passing gas or air and partly by the nearest bricks.

"Accurate pyrometry of air and furnace gases is one of the most difficult of thermometric measurements. The gas in usually transparent, hence emits no visible light by which to judge its temperature. Its heat radiation is highly selective, dependent upon the percentage of carbon dioxide and water as well as upon the depth of the radiating mass, hence the radiation pyrometer is useless. The contact (thermoelectric) method gives incorrect results because the thermometer may be as much influenced by radiation to and from its surroundings as it is by the temperature of the enveloping gas. Some form of suction pyrometer must therefore be used, the thermocouple being protected against radiation by a relatively non-conducting envelope, while a sample of the gas is drawn continuously past it to bring it up to the gas temperature. The whole apparatus should be of low heat capacity to

favor accuracy when the gas temperature is changing rapidly.

"Pyrometry of the furnace gases is consequently a research job, intended primarily to secure new information.

"The effects of furnace leakage on temperature deserve a passing mention. Infiltration of cold air, through doors and through leaky regenerators and flues, might logically be expected to lead to cooler exit gases and cooler regenerators. Precisely the opposite is the usual effect. It must be remembered that we are not operating the furnace just to burn up oil or gas; we are trying to melt scrap and make steel, and the furnace has a job to do. If a leaky furnace leads to inefficient operation and greater waste of heat units, more fuel has to be burned and everything tends to run hotter. Sweeping statements like this must be made with caution, however; I know of several cases where stopping the air leakage slowed down the furnace instead of improving it. The answer, obviously, is to look more carefully into the conditions of combustion in such furnaces.

"The temperature of the flame and the gases is so closely bound up with the problem of heat transfer from the source to the work that I wish to comment on one important aspect of the problem, concerned with surface temperatures, namely: the geometry of the furnace. To simplify the statement, let us picture a perfectly insulated operating open-hearth furnace, including regenerators, flues and stack. Let us suddenly close the valves on the incoming fuel and air, and plunge the whole thing, stack and all, into a perfect vacuum. The furnace will still continue to lose heat out the top of the stack, *by radiation.* The bath will radiate to the port roof, the port roof to the endwall, the endwall into the checkerwork, the checker brick surfaces into the flue, the flue to the inside of the stack, the inner surface of the stack, finally, to the universe. Each of these absorbing and emitting surfaces has behind it a material with a finite heat capacity, so it will take a little time to set up anything approaching a steady state of radiant flow, but radiation will inevitably drain the heat out of this perfectly insulated furnace through the only remaining opening. It is true that radiant heat energy is transferred with the speed of light, 186,000 miles per sec., but only in *straight lines.* What counts, then, is how many uninterrupted straight lines can you draw inside your furnace, and what points do they connect? While drawing these straight lines, remember also that specular reflection constitutes a straight path, as far as radiant energy is concerned.

"In the actual, poorly insulated, furnace, the succession of absorbing and emitting walls has not only a heat capacity, but also a conductivity whereby some of the absorbed radiant energy reaches the outside world without being re-emitted. Furthermore, the masses of gas in the furnace are rather opaque to certain wave-lengths characteristic of CO_2 and H_2O; and the flame itself, if luminous with carbon particles, stops a considerable fraction of the spectrum though not all. The importance of straight-line radiation as a factor in temperature distribution, nevertheless, remains. Basically, it is a problem in geometry and topology, not physics."

SYLVANIA TESTS NEW HIGHWAY LIGHTING

A new method of illuminating bridges and highways, which allows motorists greater safety than conventional lighting systems and eliminates the need for headlights, is being tested by engineers of Sylvania Electric Products, Inc., in an experimental fluorescent lighting installation at Salem, Mass. The test is being conducted on a 500-foot section of the Kernwood Bridge and preliminary results indicate that excellent visibility is attained when continuous, low-brightness fluorescent lamps are used.

The installation consists of a row of eight-foot slimline fluorescent lamps mounted five feet above the roadway on a fence rail along one side of the bridge. The use of a continuous line of light overcomes motorists' objections to the "blinking" effect experienced when low-mounted incandescent lamps were tried in an attempt to avoid poles or other vertical obstructions, and virtually eliminates uncomfortable glare from the light source itself.

Specular reflectors throw the light across the 32-foot road to illuminate the sidewalk and curbing and sufficient illumination is produced to enable motorists to drive through the area without the use of headlights. A louver is provided on the fixture which shields the lamp from the eyes of the motorist.

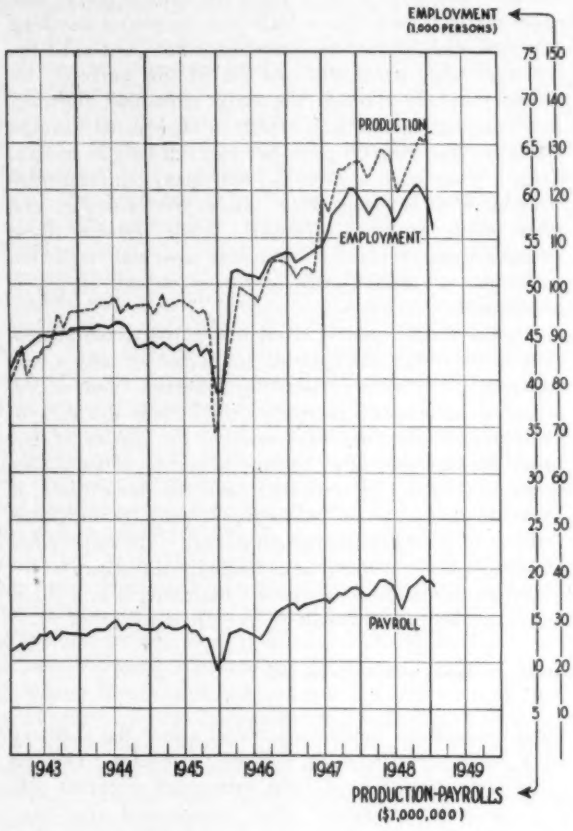
OWENS-ILLINOIS STAFF CHANGES

Two changes in the field organization of the Market Development Department has been announced by Owens-Illinois Glass Company. Newell A. Pontet, district manager for the Western area of the Glass Container Division in Chicago, is being transferred to the Dallas branch where he will cover the Southern and Southwestern territory. He will be succeeded in Chicago by George Deppman, Toledo field merchandising representative.

Mr. Pontet has been associated with Owens-Illinois for sixteen years and has served with the Army Air Force during the last war. Mr. Deppman joined Owens-Illinois in October 1947 following associations with Cargill, Inc. and the Carnation Milk Company.

CURRENT STATISTICAL POSITION OF GLASS

THE GLASS INDUSTRY'S INDEX



The Production Index for the month of January 1949 indicated a decrease for the first month of the year. Production was an estimated $67,000,000, which is about 3 per cent below the estimated $69,500,000 reported for the month of December 1948. During January 1948, estimated production was $61,700,000, or about 8½ per cent below January this year.

Employment and payrolls: During January 1949, employment was 113,600, as compared with 118,800 persons employed during the previous month. This indicates a drop of 4 per cent. During January 1948, employment was 117,200, or 3 per cent higher than for January this year.

Payrolls for the month of January 1949 were estimated to be $18,350,000. This is close to 8½ per cent lower than the December 1948 estimated payrolls of $19,000,000.

Glass container production, based on figures released by the Bureau of Census, rose 9 per cent to reach 7,388,186 gross for the month of January 1949. The previous month's production total was 6,764,567 gross. During January 1948, production was 8,055,842 gross, or 8 per cent above January this year.

Shipments for the month of January 1949 also indicated an increase. 6,480,510 gross of glass containers were shipped during the month compared with 6,302,671 gross shipped during December 1948—a difference of close to 3 per cent. During January 1948, shipments were 7,417,507 gross, or 12 per cent above January 1949.

Stocks on hand at the close of January 1949 rose 10 per cent from the December 1948 stocks of 8,752,662 gross to reach 9,643,447 gross. Stocks on hand at the close of January 1948 were 8,414,716 gross, or 14½ per cent below January this year.

Glass container production for the month of February 1949 was reported to be 6,503,125 gross. This represents a decrease of almost 12 per cent from the 7,388,186 gross produced during January. During February 1948, production was 7,335,393 gross, or 11 per cent above February this year. Total glass container produc-

GLASS CONTAINER SHIPMENTS

(All figures in Gross)

	January 1949
Narrow Neck Containers	
Foods	616,102
Medicinal & Health Supplies	986,543
Chemicals, Household & Industrial	419,759
Beverages, Returnable	156,520
Beverages, Non-returnable	4,084
Beer, Returnable	144,435
Beer, Non-returnable	167,501
Liquors	549,719
Wines	244,837
Toiletries & Cosmetics	369,945
Sub-total (Narrow)	3,659,445
Wide Mouth Containers	
Foods	1,679,603
Dairy Products	277,750
Home Canning	15,776
Medicinal & Health Supplies	298,818
Chemicals, Household & Industrial	87,429
Toiletries & Cosmetics	160,640
Packers' Tumblers	94,624
Sub-total (Wide)	2,614,640
Total Domestic	6,274,085
Export Shipments	206,425
Total Shipments	6,480,510

GLASS CONTAINER PRODUCTION AND INVENTORY

(All figures in Gross)

		Production January 1949	Stocks January 1949
Foods; Medicinal & Health Supplies; Chemicals, Household & Industrial; Toiletries and Cosmetics	Narrow Neck	2,768,061	3,298,031
	Wide Mouth	2,505,665	2,171,855
Dairy Products		327,776	242,046
Home Canning		*104,007	1,087,123
Beverages, Returnable		240,903	622,839
Beverages, Non-returnable		4,574	3,073
Beer, Returnable		192,559	797,496
Beer, Non-returnable		260,121	464,272
Liquors		591,309	583,850
Wines		279,846	277,963
Packers' Tumblers		113,365	94,899
Total		7,388,186	9,643,447

* This figure represents fruit jars only.

tion for the first two months of 1949 has reached 13,891,311 gross, or 9 per cent below the 15,391,235 gross produced during the corresponding period in 1948.

Shipments of glass containers during February 1949 fell off 5 per cent from the 6,480,510 gross shipped during January to reach a total of 6,148,625 gross. During February 1948, shipments were 7,197,491 gross, or 14½ per cent above February 1949. At the close of the first two months of 1948, 12,629,135 gross of glass containers had been shipped, as compared with 14,614,998 gross shipped during the same period in 1948—a difference of 13½ per cent.

Stocks on hand at the close of February 1949 were 9,688,722 gross, as compared with 9,643,447 gross at the close of January and 8,511,015 gross on hand at the close of February 1948.

Automatic tumbler production showed an increase for the first time in the past few months and reached a production total for February 1949 of 4,854,763 dozens. This is close to 3 per cent above the 4,722,279 dozens produced during January. Production during February 1948 was 4,325,496 dozens. For February 1949, shipments also spurted and were about 6½ per cent above the previous month's 4,287,988 dozens. February shipments were 4,574,584 dozens. During February 1948, automatic tumbler shipments were 4,295,901 dozens. Stocks on hand at the close of February 1949 were 8,715,601 dozens, as compared with 8,366,426 dozens at the close of January and 8,741,301 dozens at the close of February 1948.

Table, kitchen and household glassware: Manufacturers' sales of machine-made table, kitchen and household glassware for the month of February 1949 jumped more than 12½ per cent to reach 3,333,932 dozens. Sales during January were 2,958,588 dozens and during February 1948 they were 3,051,054 dozens. Total sales at the close of the 12-month period ending February 1949 were 41,093,329 dozens, as compared with 41,445,087 dozens at the close of the same period in 1948.

The figures for automatic tumbler production and sales of table, kitchen and household glassware of two manufacturers are estimated due to their inability to meet THE GLASS INDUSTRY's deadline. However, the totals for these concerns have been estimated in order to complete the compilation of total industry figures. These total figures will be adjusted in the next issue of THE GLASS INDUSTRY.

GLASS CONTAINER SHIPMENTS

(All figures in Gross)

	February 1949
Narrow Neck Containers	
Foods	571,946
Medicinal & Health Supplies	912,644
Chemicals, Household & Industrial	461,826
Beverages, Returnable	212,282
Beverages, Non-returnable	2,819
Beer, Returnable	155,239
Beer, Non-returnable	156,408
Liquors	574,850
Wines	246,622
Toiletries & Cosmetics	308,738
Sub-total (Narrow)	2,255,154
Wide Mouth Containers	
Foods	1,537,864
Dairy Products	243,392
Home Canning	36,870
Medicinal & Health Supplies	238,319
Chemicals, Household & Industrial	81,189
Toiletries & Cosmetics	130,979
Packers' Tumblers	98,613
Sub-total (Wide)	1,988,351
Total Domestic	5,970,600
Export Shipments	178,025
Total Shipments	6,148,625

GLASS CONTAINER PRODUCTION AND INVENTORY

(All figures in Gross)

		Production February 1949	Stocks February 1949
Foods; Medicinal & Health Supplies; Chemicals, Household & Industrial; Toiletries and Cosmetics	Narrow Neck	2,443,331	3,376,582
	Wide Mouth	2,023,083	2,172,635
Dairy Products		273,422	264,186
Home Canning		115,257	930,100
Beverages, Returnable		340,748	687,457
Beverages, Non-returnable		3,658	3,770
Beer, Returnable		230,086	862,997
Beer, Non-returnable		132,651	434,931
Liquors		538,879	532,527
Wines		294,080	317,530
Packers' Tumblers		107,930	106,007
Total		6,503,125	9,688,722

FOREIGN TRADE & EXPORT STATISTICS FOR 1948

The Department of Commerce has just released preliminary 1948 export totals which indicate a considerable decrease from the high of 1947. The loss in handmade ware exports bears out predictions that as soon as foreign countries began to produce handmade glassware, the increasing trend of exports of that ware during the war years would be quickly reversed and very small amounts would be exported.

Declines in other lines are undoubtedly due to lack of U. S. dollars in spite of dollar assistance which ERP is extending, which has caused import embargoes to be placed on many consumer articles in countries that during the war were good customers.

The following table gives a comparison by classifications of certain types of ware for the years 1946, 1947 and 1948:

Classification	Year 1948	1947	1946
Auto. Machine Tumb.	$ 2,275,558	$ 4,292,863	$ 3,962,280
Dozens	4,244,968	8,713,673	8,190,297
Av. Price per Doz.	53.6¢	49.3¢	48.4¢
Hand Made Tumb. & Stemware	$ 88,615	$ 202,067	$ 323,617
Dozens	28,352	80,454	133,832
Av. Price per Doz.	$ 3.13	$ 2.512	$ 2.418
Auto. Mach. Table & Kitchen	$ 8,560,925	$14,483,546	$10,939,400
Dozens	11,739,991	16,031,780	11,379,582
Av. Price per Doz.	72.9¢	90.3¢	96.1¢
Hand Made Table & Kitchen	$ 319,479	$ 905,500	$ 1,178,913
Dozens	72,861	204,364	278,204
Av. Price per Doz.	$ 4.38	$ 4.431	$ 4.238
Lamp Chimneys & Lant. Gl'b.	$ 878,643	$ 884,766	$ 590,764
Globes & Shades Lighting	$ 1,378,787	$ 1,659,803	$ 1,358,425
Glassware Chemical	$ 2,654,984	$ 2,826,586	$ 1,959,109
El. Glass Insulators	$ 462,008	$ 552,773	$ 359,905
Glass NES, includes ornamental, industrial, Electric lamp blanks, tubing, etc.	$ 8,397,796	$10,017,437	$ 5,840,380

CUSTOMS COURT DECISION . . .

(*Continued from page* 211)

Judge Joseph R. Jackson objected vigorously in a 25-page dissenting opinion which took a diametrically opposite position. He was joined by Judge Noble J. Johnson. The dissent argued that the court should follow the reasoning it applied in the Reidel case. Judge Jackson supported this in a lengthy legal argument on the meaning of the term "automatic" as applied to glass blowing. He concluded that the machine in which the imported goods were made was "no more automatic than a pancake griddle." Continuing the comparison, he said "a measured quantity of batter is placed on the griddle. After the cake has been cooked on one side it is turned manually and cooked on the other side. When it has been cooked on both sides it is removed by hand as a finished article."

Judge Jackson quoted with approval the lower court's opinion that "the intent of Congress . . . was to protect American glass blowers against the competition of lower paid glass blowers of other nations by providing a duty of 75 per centum ad valorem for all bottles produced otherwise than by automatic machine." He added that it was the purpose of Congress to apply a lower rate only to one type of bottle—namely those produced by automatic machinery.

AMERICAN GLASSWARE ASSOCIATION OPPOSES PROPOSED MOLD RATINGS

H. S. McCafferty, representing the American Glassware Association, formally protested proposed changes in classification ratings on molds, bottle or glassware, cast iron, in both LCL and carload quantities.

The present classification on these commodities when loose or in bundles is Second Class in all three Classification Territories in LCL lots. In carload lots, the minimum weight in all territories is 24,000 lbs. per car, subject to Rule 34, with rating of Column 40 in Official Classification Territory, Fifth Class in Southern Classification Territory and Class "A" in Western Classification Territory. The same commodity, LCL, in barrels, boxes or crates is rated at Third Class in all three Classification Territories, while in carloads the minimum weight is 24,000 lbs., subject to Rule 34, with rating of Column 40 in Official Classification Territory, Fifth Class in Southern Classification Territory and Class "A" in Western Classification Territory.

The American Glassware Association objects, in particular, to the elimination of the provisions of the Classification whereby the molds can be shipped loose or in bundles. Mr. McCafferty further stated that the Association knew of no transportation reason why there should not be a dual rating continued in the Uniform Classification whereby manufacturers of these commodities, or receivers of these commodities, cannot continue to ship in LCL lots, loose or in bundles, as well as in barrels, boxes or crates since the transportation characteristics of molds are akin to castings or forgings.

• Leonard T. Beale, President of Pennsylvania Salt Manufacturing Company was re-elected a member of the National Industrial Conference Board for the forthcoming year.

GLASS CONTAINER MANUFACTURERS INSTITUTE SPRING MEETING

The 1949 Spring Meeting of the Glass Container Manufacturers Institute will be held May 23, 24 and 25 at The Greenbrier, White Sulphur Springs, West Virginia, it has been announced.

On May 23 and 24, meetings will be held under the auspices of the Board of Trustees for the purpose of receiving semi-annual reports from the nine standing committees and making them available to the industry.

On May 25, the annual membership meeting will be held open only to glass container and closure manufacturers and allied and supplier companies that are regular members of the Institute. Of the business to be transacted is the election of three Trustees to serve a three-year term.

FUEL EFFICIENCY SUPPLEMENTS AVAILABLE

The Society of Glass Technology has announced the publication of a volume discussing efficient use of fuel. During the War, a Joint Sub-Committee was set up by the Society of Glass Technology and the Glass Delegacy to offer advice and assistance to the glass industry in the efficient use of fuel. In January 1944, the Sub-Committee published and issued to all members of the glass industry operating glass melting furnaces, the first record of its work in the form of a Fuel Efficiency.

Ten Supplements were issued and since these are now out of print, the Sub-Committee has recently published them in a single volume. The volume is available to members of the Society at the following prices: Paper-backed, 25 shillings; Cloth-bound, 27 shillings, sixpence. The prices of the volume to non-members are 2 pounds, 2 shillings for the paper-backed issue, and 2 pounds, 4 shillings, sixpence.

BOOK REVIEW

Scientific and Industrial Glass
Blowing and Laboratory Techniques
By W. E. Barr and Victor J. Anhorn

This book is directed to the experimentalist in using glass and to the laboratory worker for designing complex equipment more intelligently. The authors had three objectives in presenting the book. First, they have pointed out and described characteristics of various laboratory glasses as well as the fundamental techniques involved in handling glass.

Secondly, the authors have presented advanced techniques as the application of high vacuum, silvering and the evacuation of glass jackets to the construction of glass equipment. The third objective was to describe glass equipment for specific laboratory applications.

The book should teach the experimentalist, with moderate practice, to perform the simple operations himself. Skill in making small seals is now required in many types of laboratory work and the book will help him to handle as well as understand more completely the process involved. The more advanced portions of the book are intended to explain what the professional can do and to foster an understanding of the technique necessary.

Published by Instruments Publishing Company, 388 pages, $6.00.

MELTING and FINING

BORAX... B_2O_3 even in small quantities in a properly adjusted glass batch will improve the melting and fining time and thus effect a desired economy.

Another good reason why Borax should be used as an essential ingredient in the batch formula.

• • •

Our representatives are prepared to discuss all the special advantages of B_2O_3 in glass.

PACIFIC COAST BORAX COMPANY

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NEW EQUIPMENT AND SUPPLIES

MICRO HARDNESS TESTER

Kent Cliff Laboratories, Peekskill, New York, has announced its new tester for Micro Hardness Testing which, it is stated, is the first tester to apply accurately dead weight loads as light as 1 gram, for use with either the Knoop Indenter or the Vickers Type Indenter.

The Kentron tester is a bench type instrument and is hand-operated to eliminate instrument-operating vibration. An adjustable oil dash pot for controlling the speed load application and time of load retention is easily adjusted to suit specific testing requirements.

A specially built mechanical stage, consisting of three basic parts—the stationary plate, transfer plate and specimen block—provides an easy and convenient means for positively locating and positioning the exact area of the test specimen underneath the indenter and microscope. Dead weights for applying loads of 1 to 1000 grams and the most up to date optical measuring equipment are supplied as standard equipment.

NEW INFRARED ANALYZER

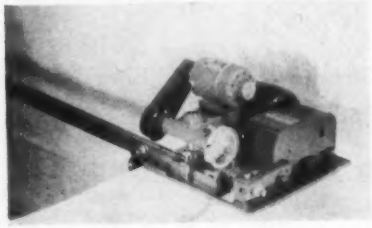
The Perkin-Elmer Corporation, Glenbrook, Conn., has announced the development of a new Infrared Analyzer for continuous automatic analyzer of as many as six different components in a flowing stream of sample. The stream may be either in the liquid or gas phase.

The instrument consists of the following units: Infrared Monochromator, similar to that used in the Perkin-Elmer Infrared Spectrometer; Turret, automatically driven, twelve point (one reference standardization point and one absorption point for each of six components); Recorder, Leeds & Northrup, 12-point, strip chart, specially designed for this instrument, automatically synchronized with turret; Amplifying Circuit, highly stable, a.c. operation, compensates for changes in ambient temperature, source intensity, window dirt, etc. The cycling time for a six component analysis is about six minutes.

The Model 12-D Infrared Analyzer is particularly time saving in the pilot plant in determining optimum process conditions. Operating variables such as temperature, contact time, flow rate, etc., may be varied continuously and evaluated immediately from the automatic analytical record. In a continuous, multi stage process, sampling may be performed at intermediate stages for independent evaluation.

GLASS-ROD CUTTING MACHINE

Glass Machinery Company, Fairfield, Conn., has announced the development of an automatic bench type Glass-Rod



Cutting Machine capable of cutting rods into short lengths at production rates up to 100 per minute.

Rods are fed at the rate of 15 feet per minute in sizes ranging from .150 to .275 diameter and can accommodate lengths ranging from 5/8 inches to 2 inches. An automatic magazine feed is available as optional equipment.

AUTOMATIC BURNER ASSEMBLIES

Bryant Industrial Division, 1020 London Road, Cleveland 10, Ohio, has introduced a complete automatic burner assembly for gas-firing boilers from 10-180 HP.

Only gas piping and electric wiring are needed to complete the installation of the pre-engineered elements of the new Series BB Boiler Burners which are shipped as complete packages, including protective equipment and pressure controls. Principal element of the boiler burner is the Bryant Pow-R-Sembly, including constant pressure blower, single or double burner nozzles each with compact proportional mixer, zero regulator, motorized air valve, electric ignition pilot and manual reset safety gas valve. Steam pressure controls, remote thermostatic control, or both, are furnished in the packeted unit.

The Bryant boiler burners operate automatically over three steps of heat output. For light loads, the pilot operates, while the main burner automatically takes over at "low fire" or "full fire" as required. The burners are supplied with valves sized for manufactured and mixed gas, or for natural and LP gas. Bryant square flange connections throughout make possible a flexible arrangement of elements to suit installation space available.

CATALOGUES RECEIVED

The Rapids-Standard Company, Inc., Dept. BC-174, 342 Rapistan Building, Grand Rapids 2, Michigan, has published a new, four-page bulletin describing and illustrating the Rapid Power Booster power belt conveyor line.

The Challenge and Defender models are illustrated in the bulletin, with construction features singled out and listed separately. The bulletin is sectionalized to provide related grouping of outstanding features in a single panel for ease of reading.

Mathieson Chemical Corporation, 60 East 42nd Street, New York 17, New York, has published a new booklet, "Mathieson Chemicals", covering the history, operations and products of the company.

The 32-page illustrated booklet gives information on methods of production, properties and applications of caustic soda, soda ash, bicarbonate of soda, liquid chlorine, ammonia, dry ice and carbonic gas, hypochlorite products, sodium methylate, sodium chlorite and chlorine dioxide, and various specialties. The booklet also includes a description of the recently developed stationary mercury cell for the production of chlorine and caustic soda.

The North American Mfg. Company, 4455 E. 71st Street, Cleveland 5, Ohio, has issued Bulletin 225S featuring its dual-fuel burners.

The burner is illustrated and several operating and maintenance features are given.

Jessop Steel Company, Washington, Pa., has issued a new booklet describing its stainless and heat resisting steels, tool and die steels, and cast-to-shape steels. Typical analysis and applications are included for each brand.

Walsh Refractories Corporation, Dept. P-2, 4070 N. First Street, St. Louis 7, Mo., has released a new bulletin entitled, "Here's Longer Life for Your Furnace Linings". The bulletin features Walsh Plastic Fire Brick, the modern monolithic refractory.

The Chas. Taylor Sons Co., Cincinnati, Ohio, has released an illustrated 6-page bulletin, No. 507, describing "Tayco-40", high temperature silica cement.

The bulletin gives a complete description of the properties of the cement and its application for bonding silica and super-duty silica refractories used in the construction of glass melting, open-hearth and electric arc melting furnaces.

Call on DRAKENFELD, your partner in solving color problems

● Why debate over colors that mature too late or too soon when there's a good chance to save time, materials and money by calling on Drakenfeld?

Want a new color? Want to match an old one? Want colors that really fit? Over the years, Drakenfeld has solved many such problems for glass and ceramic manufacturers. As a result, they found it possible to produce better ware at greater profit—increase production and minimize rejects. You can be certain that we will give the same careful study and practical analysis to *your* color problems and that our recommendations will include full consideration of your particular methods of production.

Give us the opportunity to demonstrate how our color research facilities and trained technologists can be of real help to you. This cooperative service may prove to be just what you need to pave the way to lower costs. Phone or write for a meeting date to suit your convenience.

DEPENDABLE SERVICE ON:

Acid, Alkali and Sulphide Resistant Glass Colors and Enamels . . . Crystal Ices . . . Squeegee and Printing Oils . . . Spraying and Banding Mediums . . . Glassmakers' Chemicals . . . Glass Decolorizers . . . Decorating Supplies.

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Braun-Knecht-Heimann Co., San Francisco 19

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Malleables for plugging moulds will pein readily. We have above sizes available for immediate shipment. Other bars available in sizes you want. Your inquiry will bring complete information on Alloy Iron Castings, for Plungers, Ring Sticks and Guide Rings.

The HAVEN
MALLEABLE CASTINGS CO.
DANE & KNOWLTON STS. PHONE KIRBY 3581
CINCINNATI 23, OHIO

THATCHER'S MEN'S CLUB . . .

(*Continued from page* 210)

employees and with his own practical acquaintance with every factory production operation, any labor problem usually reaches him by way of worker to foreman or shop steward to Personnel Counsel, and to the Personnel Director, if necessary, who is F. K. Rodewald, Executive Vice President.

How effective is the company's employee relations history in which Bill Davies and the Thatcher Men's Club play so important a part is testified to by the fact that the company has never had a strike, and management and employees have spent a minimum of time around the conference table away from the making and selling of glass.

"Humanic" is the word for Bill Davies, a word he coined himself in a notable human document he recently prepared and circulated on his own initiative among foremen and supervisors at the Thatcher plant. It's worth repeating here and in many other places:

"No business today can succeed and progress any faster than the quality of the foremen in the front ranks. They represent management to the men and men to the management. It is in the hands of these men that management places the responsibility for the interpretation of contract, submission of orders, and listening to complaints, criticisms and suggestions.

"Grievances are often caused because the foreman doesn't listen. This causes resentment which soon spreads to the rest of the working force.

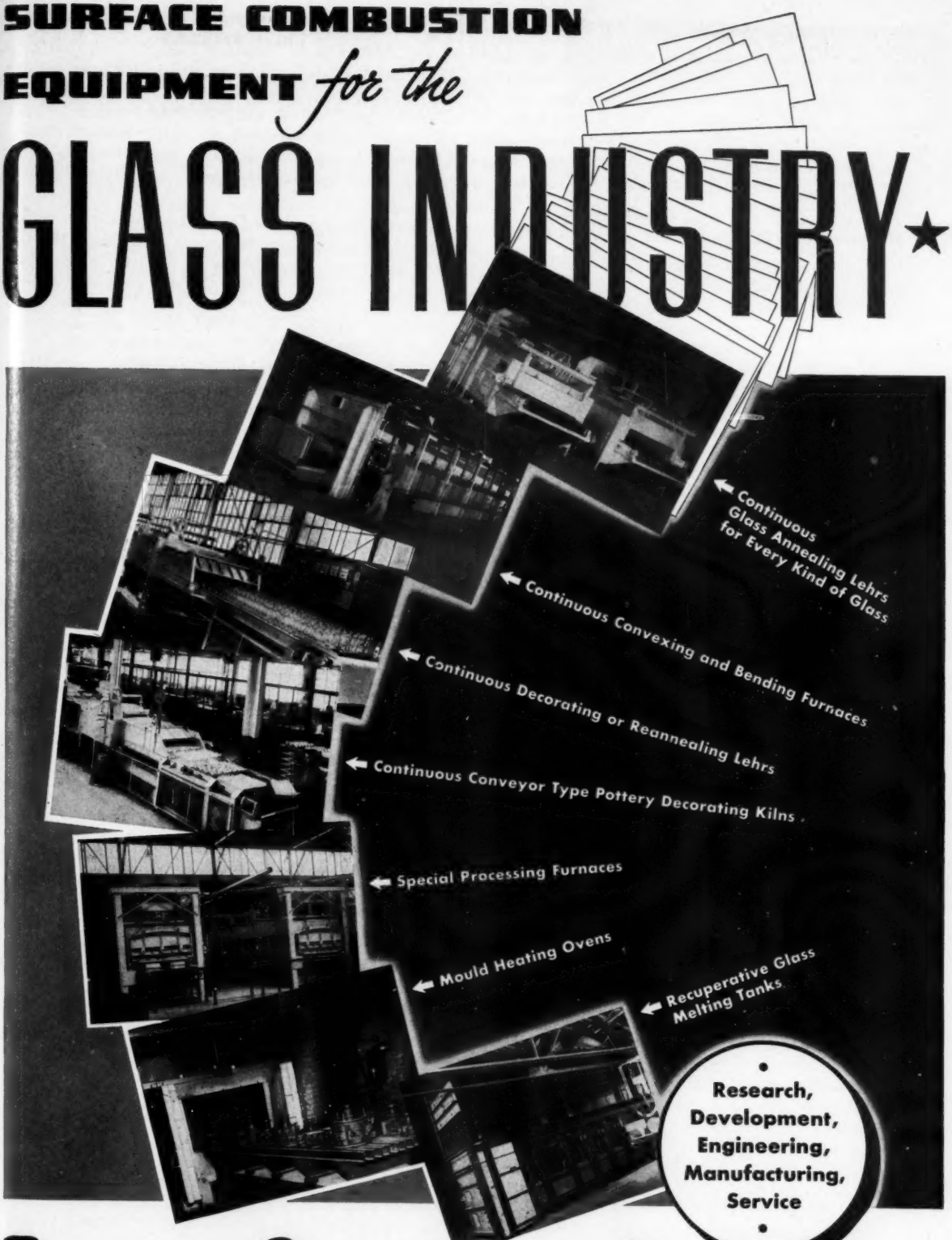
"Don't lose sight of the fact that a successful foreman must be a capable Personnel Officer under today's system of industrial life. *He must consider 'humanics' as important as mechanics.* He may know how the job is to be done with the most efficient men at the lowest cost, but if he is not a leader of men or doesn't know how to handle men, he may soon find he is causing an industrial relations situation that will involve his company in severe labor trouble. The foreman's job responsibility to the company: First, he must remember that it is the company that has given him the opportunity to work and advance to the position of foreman. To this company he owes his first responsibility. This responsibility must be recognized by every outstanding foreman. In the performance of his duty he should: A. Enforce and practice all safety rules and regulations of the company; B. Support with honesty the laws of the land and live up to the contract of the union; C. Protect company property at all times; D. Develop a good organization by building men who can carry on in years to come; E. Use and boost the company's products when practicable; F. Maintain high efficiency standards. Do his best to build morale; G. Be a good citizen outside the plant, obey all civilian laws, command the respect of his workers outside as well as inside the plant; H. Boost his company's good name at every opportunity; I. Promote economy and prevent waste; J. Report immediately to his Personnel Director or Plant Manager any condition or unrest that is taking place in the company so that necessary and proper steps may be taken to adjust grievances.

"Remember, that's the Foreman's job.

"We have been talking about the responsibility of the

(*Continued on page* 237)

SURFACE COMBUSTION
EQUIPMENT *for the*
GLASS INDUSTRY★


Continuous Glass Annealing Lehrs for Every Kind of Glass
Continuous Convexing and Bending Furnaces
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Continuous Conveyor Type Pottery Decorating Kilns
Special Processing Furnaces
Mould Heating Ovens
Recuperative Glass Melting Tanks
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SURFACE COMBUSTION CORPORATION
TOLEDO 1, OHIO

G.C.M.I. ISSUES MARKETING TRADEPAPER

The Glass Container Manufacturers Institute has published the first edition of its new marketing tradepaper, "Glass Container News". Offset printed and issued monthly, the merchandising organ will have a free circulation of 27,000 and will circulate among brewers, beverage distributors, food retailers, appropriate trade associations, advertising agencies and tradepaper editors.

REPORT ON DURABILITY OF PHARMACEUTICAL GLASS CONTAINERS

The report of the Glass Containers Advisory Committee of the United States Pharmacopœia on the durability of glass containers which forms the basis for the projected standards for four basic types of glass containers used for parenteral solutions for U.S.P. XIV and N.F. IX appears in the March-April issue of the *Bulletin of the National Formulary Committee.*

Coordinated with the activities of this Committee have been those of the American Society for Testing Materials Subcommittee VII-A, Pharmaceutical Containers. These two interlocking committees have been working since 1943 to improve and simplify methods for testing the resistance of pharmaceutical glass containers to attack by liquids contained therein.

Copies of the *Bulletin* may be obtained from the American Pharmaceutical Association, 2215 Constitution Avenue, N.W., Washington 7, D. C., at the cost of $1.00 per copy.

L-O-F REDUCES FACTORY PRICES ON STANDARD SIZE THERMOPANE

Libbey-Owens-Ford Glass Company has announced a five per cent reduction in factory price for standard sizes of Thermopane to go into double-hung wood and residential metal sash.

The price reduction, according to the company's statement, is the result of increasing volume of sales and improved manufacturing techniques making them able to reduce production cost on the standard sizes.

MINNEAPOLIS-HONEYWELL TO ACQUIRE VALVE COMPANY

Minneapolis-Honeywell Regulator Company has announced that it has entered an agreement for the acquisition of the assets of the H. Belfield Company, manufacturer of control valves.

Founded in 1836, the Belfield company has pioneered in the design of valves for the railroad, coal, gas, oil and chemical industries. The new acquisition will enable the Honeywell company to supply its own control valves for application in connection with industrial controlling instruments of the type made by the company and its Brown Instruments Division.

Howard L. Murray, President of Belfield, will be elected a Vice President of Minneapolis-Honeywell and will be in charge of the new acquisition which will be known as the Belfield Valve Division of Minneapolis-Honeywell. All personnel of Belfield will continue with the company in their same capacities.

• Pittsburgh Plate Glass Company has named M. A. Edleman as Manager of the firm's Duluth, Minnesota, warehouse, and J. R. Whitmer as Manager of the La-Crosse, Wisconsin, store.

FTC ORDER CONCERNING GLASS SUBSTITUTES

The Federal Trade Commission had issued an order for Harold Warp, doing business as Flex-O-Glass Manufacturing Company and as Warp Brothers, together with his advertising agency and its officers, to stop misrepresenting the properties and effectiveness of glass substitutes designated Flex-O-Glass, Wyr-O-Glass, Glass-O-Net and Screen Glass.

The order followed the Commission's findings that the respondents had represented, among other things, that the glass substitutes are superior to ordinary glass when used in buildings for poultry and pigs because they permit the passage of ultraviolet rays of sunlight. The respondents further claimed that chicks cannot survive without ultraviolet rays; that poultry which is raised or kept in buildings containing the glass substitutes will be healthier, grow to a given size more rapidly, start laying earlier and lay more eggs than those raised and kept in buildings where common glass or other glass substitutes are used.

The Commission's findings that ultraviolet rays are not essential to the growth, health, development or nutrition of birds or animals and that such representations "are grossly exaggerated, false, misleading and deceptive" were responsible for the order restraining such representation.

The Commission pointed out that "the only known value of ultraviolet rays in connection with the existence and well being of birds or animals is in converting certain body elements into Vitamin D", and that the products would be beneficial only when the diet of birds or animals is deficient in Vitamin D. Adding that the extent of the benefit will be dependent on many factors, the Commission reported that "there are many circumstances in which the use of said products will give no benefits over common glass."

Other findings of the Commission were to the effect that the products are not superior to common glass in keeping heat in and cold out; that common glass will not kill chicks kept under it; that many other glass substitutes permit the passage of ultraviolate rays to an extent equal to or greater than Flex-O-Glass; and that passage of sunlight through Warp's products does not result in a "mysterious spectronic supplement".

SAM TOUR COMPANY ADDS TO STAFF

Announcement has been made by Sam Tour & Company of the addition of Harold F. Stose to head the company's Chemical Engineering Department. Mr. Stose has had more than twenty years experience in chemical research, product development and management of laboratory activities.

Formerly associated with Owens-Illinois Glass Company, Radio Inventions, Inc., American Chicle Company, Hood Rubber Company and RCA-Victor Company, Mr. Stose has been in charge of chemical research groups with these organizations.

• Kenneth E. Rideout, who has been field representative in the Atlanta district for Libbey-Owens-Ford Glass Company for the past two years, has been named resident field representative in Miami, Florida. Mr. Rideout has been associated with the company for ten years.

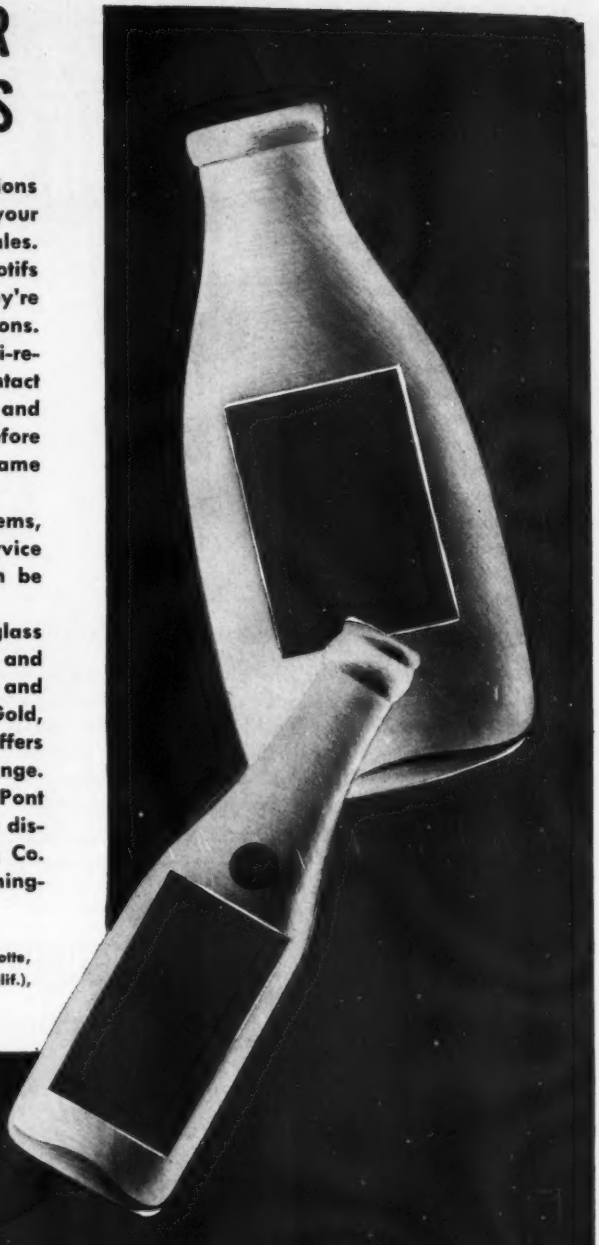
"SALES TONIC" FOR GLASS CONTAINERS

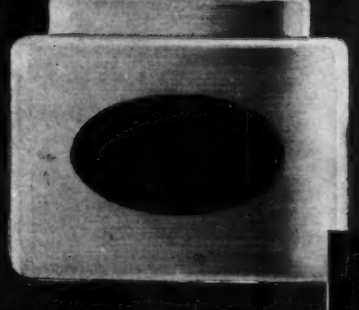
Distinctive labels and colorful decorations produced with Du Pont Glass Colors give your product that extra "tonic" that stimulates sales. Du Pont colors are adaptable to simple motifs or the heaviest of multi-layer designs. They're easily applied; give smooth, even applications. And they're durable. Both acid- *and* alkali-resistant, they are unaffected by constant contact with foods, withstand repeated washing and sterilization. Du Pont colors are pretested before shipment so that they always meet the same high standards.

To assist you with your decorating problems, Du Pont maintains a Technical Staff and Service Laboratory. Trial runs on your ware can be made in our laboratory or in your plant.

Make Du Pont your headquarters for glass and ceramic colors of all types, overglaze and underglaze, body, slip, and glaze stains and Squeegee Oil. Also, Du Pont Liquid Bright Gold, a uniformly true metallic decoration that offers exceptional coverage over a wide firing range. For complete information on the use of Du Pont Colors on your products, call our nearest district office: E. I. du Pont de Nemours & Co. (Inc.), Electrochemicals Department, Wilmington 98, Delaware.

DISTRICT SALES OFFICES: Baltimore, Boston, Charlotte, Chicago, Cincinnati, Cleveland, Detroit, El Monte (Calif.), New York, Philadelphia, Pittsburgh, San Francisco.





DU PONT

DU PONT
COLORS and DECORATIONS
for **GLASS** *and* **CERAMICS**

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

Tune in to the Du Pont "Cavalcade of America"
Monday Nights—NBC Coast to Coast

INVENTIONS AND INVENTORS . . .

(*Continued from page* 217)

The figure shows a section through the end of a day tank embodying invention. The glass is melted in a container 2 in the furnace chamber 3, the glass passing through an outlet 4 to a trough 7 in the glass receiving chamber 8. The trough has an opening 9 in the bottom through which the glass in discharged continuously onto a shaping element 10 from which it passes as a tube W to rollers by which it is conveyed to a station where it is cut into the desired lengths.

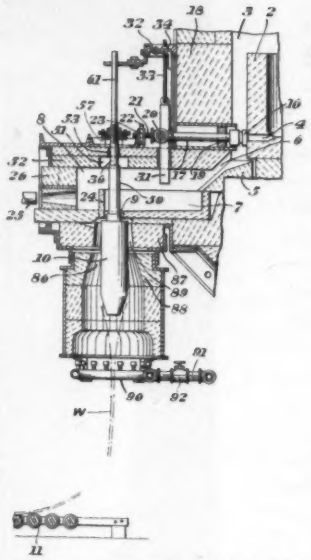


Fig. 10. Patent No. 2,464,028.

The flow of glass from the container 2 is regulated by a member 16 which can be adjusted by a hand wheel 22. The glass in the chamber 8 is heated by a burner 25 where the heat is confined by a curtain block 31. The vertical position of the curtain block may be adjusted by nuts 34. The lower end of the shaping element 10 is tapered so that the tube is reduced in diameter and it may be adjusted vertically and horizontally through connections to the pipe 36. The arrangement is such that the molten glass flows down on both the outside and the inside of the shaping element. The upper end of the pipe 36 is connected to a pipe 61 which supplies blowing air for cooling the glass and assisting in the formation of the tube. A heating or cooling device is provided by the burner 90.

By this construction, glass flows down the inside and outside of the shaping element which prevents drawing lines and at the same time increases the speed of drawing the tube.

The following references are of record in the file of this patent: United States Patents: 2,069,377, Mattiessen, Feb. 2, 1937 and 2,133,662, Gray, Oct. 18, 1938.

L-O-F ADDS TO STRUCTURAL GLASS COLORS

Production of a new dark gray color of Vitrolite structural glass has been started in the Rossford plant of Libbey-Owens-Ford Glass Company. Addition of the dark gray brings to eleven the number of colors that now are available.

The new color is being produced in two thicknesses, 11/32 of an inch and 7/16 of an inch, both with ground and polished surface. Features of the structural glass are that the colors are permanent, the surface is easily cleaned and the glass will not absorb liquids or unpleasant odors.

GLASS MACHINERY COMPANY

FAIRFIELD, CONNECTICUT, U.S.A.

Special Machinery on a No Risk Basis

Services Of Competent Technical Personnel Available At Your Location Or Our Offices

If you have hesitated to equip with modern automatic machinery because of the financial risk as to successful results, this is your solution:

1. Send us an outline of the operation or process you wish performed. You are under no obligation.
2. After a preliminary study we will submit a firm bid quotation on a machine guaranteed to perform a specified number of operations or processes per unit of time.
3. Upon completion of the machine, your acceptance is based entirely on satisfactory performance within a limited time. There are no escalator or open contract clauses.

• THE ONLY CHEAP LABOR IS GOOD AUTOMATIC MACHINERY •

• Making the best product in its field is an achievement.

But making the best is not enough. Rendering the best SERVICE is equally important.

Here, at Hommel, we have been building up our service facilities for 57 years.

By "service" we do not mean, alone, prompt shipments . . . although that is one element that all Hommel customers prize. By "service" we do not mean, solely, anticipating the needs of the industry years in advance . . . even though we are continually researching developments to have them ready when the time comes.

Nor, by "service," do we confine the definition to co-operation between our Service Engineers and the Customer and our Plant Technicians and our Laboratory Specialists . . . although this is teamwork highly valued by Hommel customers.

Hommel Service means ALL these things, and we invite you to try it.

Laboratory Controlled Production of Ceramic Supplies

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- CHEMICALS
- BRONZE POWDERS
- METAL POWDERS
- SUPPLIES
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Our Technical Staff and Samples are available to you without obligation. Let us help you with your problems.

THE HOMMEL CO.
TTSBURGH 30, PA
Pacific Coast Agents
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World's Most Complete Ceramic Supplier

ALUMINATE GLASSES . . .

(*Continued from page* 200)

efficient of expansion as compared to ordinary silicate glasses. These glasses might offer better resistance to alkali metallic vapors than silicate type.

An observation of Table II reveals a few interesting points. Glasses 3-5 and 7-12 contain component oxides whose melting points are all above 1900°C. Yet these glasses can be melted at a temperature 1450°C or lower. Glass 12 contains almost twice as many Be atoms as Al atoms and may be called a berylloaluminate glass. The relatively small amounts of CaO and $AlO_{1.5}$ should be noted. By comparing the cationic compositions of glasses 1 and 2, it is safe to predict that a corresponding sodium-glass may be synthesized with certainty. Small amounts of oxides of In, Ti, Zr, Cb, Ta and Th may be incorporated in these glasses and a clear glass results. Since these glasses were made with attention centered on their optical properties alone, it is the author's belief that aluminate glasses with compositions widely different from those previously known may be synthesized. It is hoped the present paper would stimulate research in this novel and interesting type of glasses.

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3. See, for example, W. L. Bragg, Atomic Structure of Minerals, Cornell University Press, 1937.
4. H. W. Safford and Alexander Silverman, "Alumina-Silica Relationship in Glass," Jour. Amer. Ceram. Soc., *30* (2) 203-11 (1947).
5. Data on Chemicals for Ceramic Use, National Research Council Bull. 107, compiled by K.-H. Sun under the Direction of Alexander Silverman, G. W. Morey and F. D. Rossini, 1945.
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7. J. Strong and R. T. Brice, Jour. Opt. Soc. Amer., *25*, 207 (1935).
8. Measured by P. T. Scharf of the Kodak Research Laboratories.
9. K.-H. Sun. "Contribution to Refractive Index and Abbe Value of Oxide Components in Glass," Jour. Amer. Ceram. Soc., *30* (9) 287-289 (1947).
10. J. C. Young and A. N. Finn, "Effect of Composition and Other Factors on Specific Refraction and Dispersion of Glasses," Jour. Research Natl. Bur. Standards, *25* (6) 759-782 (1941). The treatment also includes data crystalline substances.

INNIS, SPEIDEN APPOINTMENTS

Innis, Speiden & Company has announced the appointment of E. T. Ladd, Vice President and Works Manager, as Vice President in charge of the Isco Chemical Division.

At the same time, it was announced that C. H. Berle, who was appointed assistant works manager a year ago, has been appointed Works Manager of the Division.

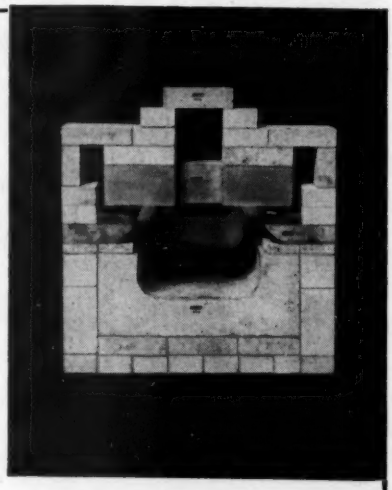
WYANDOTTE CHEMICALS ACQUIRES OHIO PROPERTY

Wyandotte Chemicals Corporation has recently acquired approximately 200 acres of land at Dilles Bottom, Ohio, located ten miles south of Wheeling, West Virginia. Included in the property is a 2300 foot frontage on the Ohio River.

The new site, acquired for future additions to the company's organic chemical facilities and for expansion of its electrolytic chlorine and caustic soda plants, has natural resources of salt, coal, oil, gas and water either on or adjacent to the property. Rail, highway and barge transportation are available as is electric power.

Cleaner Glass, Low Maintenance

with **CRYSTALITE Forehearths**



REMMEY CRYSTALITE (mullite-bonded mullite) is produced in all shapes necessary to make up the forehearth assembly. Burner blocks, cover blocks, channels, spouts, tubes, plungers and orifice rings are built to meet specified requirements. These CRYSTALITE parts mean better, more efficient production by offering:

- ★ Accuracy in formation to eliminate time-wasting adjustments.
- ★ High refractoriness and erosion resistance for longer life, fewer replacement shutdowns and cleaner glass.
- ★ Rigid control through each production phase for uniform quality and dimension accuracy.

Get Premium Performance Without Premium Price . . . by using REMMEY CRYSTALITE parts for your forehearth.

Dependable Refractories

REMMEY

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Just as the continual dripping of water wears away the hardest stone, so does the softest textile fiber wear away thread guides of the hardest metal. So scientists have sought longer-wearing materials for these tiny guides over which endless miles of thread are drawn at tremendous speeds in textile mills.

Working in the field of ceramics, researchers at American Lava Corporation found that by using a mix consisting principally of ALCOA Alumina, they could produce thread guides which would set new wear performance records.

Today thousands of thread guides, made of this unique material, known as "Alsimag"* 491, are reducing manufacturing costs throughout the textile industry—especially where the processing of fibers or filaments reduced the life of ordinary guides.

This is a typical example of how ALCOA Chemicals are used to make products better and reduce manufacturing costs. If aluminas or fluorides have any application in your business, let us tell you more about those sold under the "ALCOA" trade-mark. More and more, they are being used to improve the quality of *successful* products. Write to: ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 1467 Gulf Building, Pittsburgh 19, Pa.

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ALCOA

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ALUMINAS AND FLUORIDES

ACTIVATED ALUMINAS • CALCINED ALUMINAS • LOW SODA ALUMINAS • TABULAR ALUMINAS • HYDRATED ALUMINAS
ALUMINUM FLUORIDE • SODIUM FLUORIDE • SODIUM ACID FLUORIDE • FLUOBORIC ACID • CRYOLITE

REFRACTORIES FOR GLASS FURNACES . . .

(*Continued from page* 208)

breast walls. Because of the higher temperatures prevailing in many furnaces, the jambs of the ports frequently are built of more refractory materials. Super-duty silica brick have proved adequate for some conditions. Mullite and corundum refractories of various types are economically used in many instances.

Port necks, walls and arches frequently need to be strengthened with refractories of these classes. Among the alumina-silica refractories, super-duty fireclay and high-alumina brick of the diaspore types also are used in preference to high-duty and silica brick for moderately severe conditions. For conditions of extreme severity, brick higher in mullite or corundum may be preferable. Super-duty silica in some instances afford a sufficient margin of safety to warrant their use. The several types of basic brick also find advantageous applications for very severe conditions.

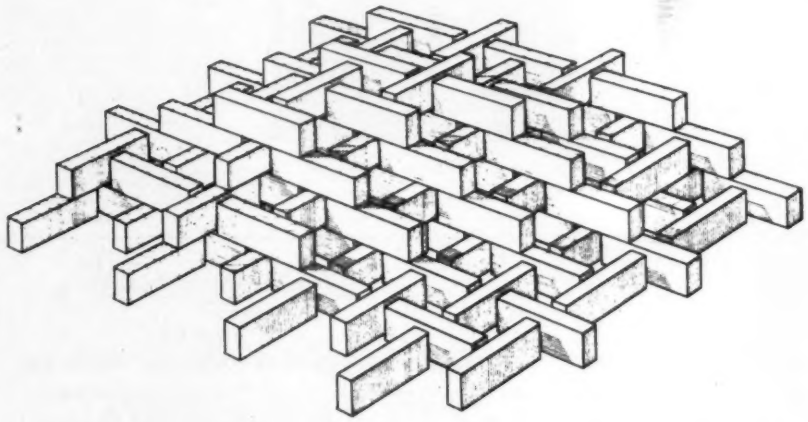
In checker settings, the efficiency of the refractories as heat reservoirs may be of less importance than other properties upon which their durability depends. The thermal efficiency is reduced as the brick are consumed, become encrusted with a deposit of batch dust, or become glazed.

Among the factors which influence the behavior of regenerator checkers, aside from the quality and type of refractories used, are the maximum temperature, the frequency and rapidity of fluctuations in temperature, the amount and composition of alkaline dust and fumes in the gases, the kind of fuel, the furnace atmosphere (whether reducing or oxidizing), and the design and construction of the setting.

Checker brick are consumed in several characteristic ways. Fluxing is perhaps the most usual destructive factor. Slabbing as mentioned above results from a reaction which is different from slagging or fluxing. With some kinds of refractories, alternate heating and cooling causes depreciation in mechanical strength. With some other kinds, exposure to alternate oxidizing and reducing atmospheres has a similar effect. Leakage of reducing gases from the gas to the air chamber can seriously affect the checkers in the air chamber.

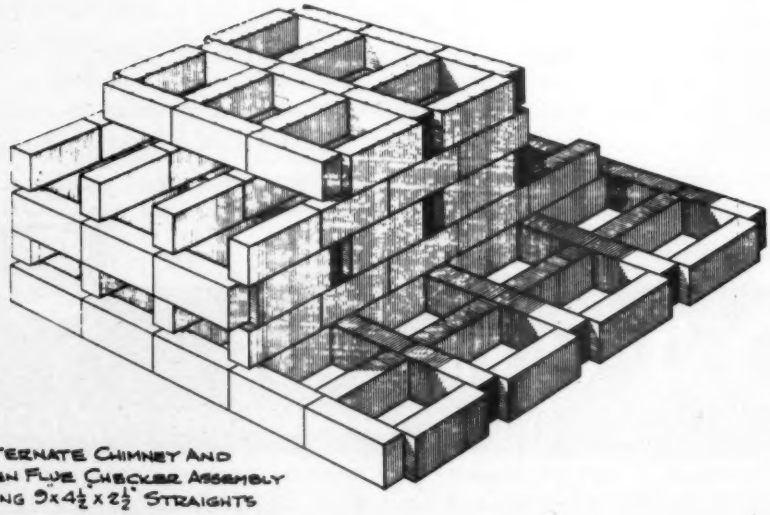
Many designs of checker settings are used. With ade-

(*Continued on page* 237)



OPEN BASKET WEAVE CHECKER ASSEMBLY
USING 13½"x4½"x2½" OR 13½"x4½"x3" STRAIGHTS.

Fig. 8. Shows Open Basket-weave Checker Assembly using 13½ x 4½ x 2½ or 13½ x 4½ x 3 Straights.



ALTERNATE CHIMNEY AND
OPEN FLUE CHECKER ASSEMBLY
USING 9x4½x2½" STRAIGHTS

Fig. 9. Shows a system which not only provides a strong construction, but also greatly facilitates lancing with air or steam. The solid vertical walls serve to confine the lancing medium and make the operation highly effective.

One of a series *of messages to help you increase your understanding of business paper advertising, and its effect on your job.*

No matter what you make —you're not making it at a profit !

YOU MAY HAVE the finest product of its kind. Your production set-up may be a miracle of efficiency. Perhaps you've even discovered how to cut your cost-per-unit below that of your closest competition. The fact remains —

You're still not *making* anything at a profit. Because actually, of course, there is no such thing.

Goods can only be *sold* at a profit. And selling them profitably requires the same kind of mechanization that keeps your production costs down.

In the *manufacture of a sale*, for example, there are five basic operations —

1. Seeking out prospects
2. Arousing their interest
3. Creating a preference for your product
4. Making a specific proposal
5. Closing the order

Any good salesman can handle all five. But no salesman should *have* to — not when the first three can be mechanized so economically through the use of advertising.

For good advertising, like the machine on your production line, is a multiplier of individual effort, enabling all of us to produce (and *earn*) far more than we could alone.

And when it goes to work in *business papers* — with their tremendous concentration of hand-picked prospects — advertising becomes the most efficient machine available for manufacturing sales at a profit!

THE GLASS INDUSTRY

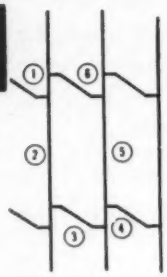
is a member of The Associated Business Papers, who have published an interesting folder entitled, "10 ways to measure advertising effectiveness." We'll be glad to send you a copy. And if you'd like reprints of this advertisement (or the entire series) to pass along to others in your organization, just say the word.

LOOKING FOR
better glass colors ?

Then you'll want to investigate Ferro's acid-resisting, applied glass colors—with wide firing range, high gloss and good coverage. Write today for further details.

COLOR DIVISION
FERRO ENAMEL CORPORATION
4150 E. 56TH STREET • CLEVELAND 5, OHIO

7 STAVES INTERLOCK



Each Super-Concrete Stave in a Neff & Fry Silo interlocks with six contiguous ones. The edges are grooved and beaded. The joints are so secure that grouting is not necessary, although a mastic filler is used when damp-proofing is specified.

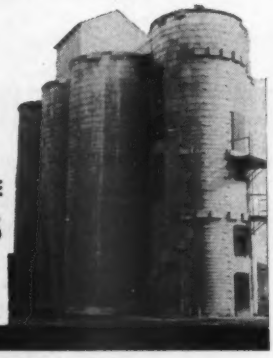
Due to the diagonal joints, reinforcing rods impinge upon both ends of all staves. As many additional rods are drawn around the bodies of the staves as needed to resist lateral pressure.

This patented design makes the N & F Silo a structure of distinctive strength and solidity. The corrosion-resistant materials assure long life with virtually no maintenance cost.

It will pay you to get complete information. Write, wire, or phone.

THE NEFF & FRY CO., Camden, Ohio

NEFF & FRY
SUPER-CONCRETE STAVE
STORAGE BINS
FOR ALL SORTS OF
FLOWABLE BULK MATERIALS



A. C. S. ANNUAL MEETING . . .

(*Continued from page* 204)

Crystals and Glasses. *By W. A. Weyl, Pennsylvania State College, State College, Pa.*

Experiments concerning the influence of asymmetrical units on the surface properties of glasses, sponsored by the Mechanics and Materials Branch of the O.N.R., led to a better understanding of the surface structure of crystalline solids. A picture is advanced which indicates a close similarity between the atomic structures of the surface layer of a crystal and that of a glass. Common to both are certain characteristic features, namely, the inconstancy of the coordination number, the internuclear distances, and the bond angles.

The difference between the surface structure and the interior of a crystal depends on the polarization properties of the ions. A schematic representation of the distribution of bond strength in ideal and real crystals, glasses, and in surface films brings out the similarity between the surface of crystals and the structure of glasses.

Based on this picture a number of apparently unrelated phenomena are discussed and explained: Devitrification of the glass surface, role of imperfections on the transformation of crystals (silica brick), sintering of highly refractory oxides, dielectric constant of polycrystalline materials, and the electric absorption of stratified dielectrics.

9. Thermal Expansion: I, a Resume. *By F. A. Hummel, Pennsylvania State College, State College, Pa.*

The importance of the reversible thermal expansion of inorganic substances is recognized by metallurgists, glass technologists and ceramists who deal with manufactured products which are subjected to temperature cycling in service. The temperature interval involved may be very small as, for example, in dental porcelain, or it may be very large as in open-hearth refractory brick. In spite of the major influence which this property has on the practical service life of industrial products, very few general principles have been advanced regarding the effect of crystal structure on the reversible thermal expansion of pure compounds. In general, close-packed crystalline structures of the sodium chloride or spinel type, which have simple geometrical arrangements, seem to have high expansions. Less symmetrical structures of lower stability, as indicated by dissociation or melting point data, apparently favor a lower expansion as, for example, the moderately refractory materials such as zircon, beryl, beta spodumene, and willemite.

Tuesday Afternoon, April 26, 1949
2:00 P.M.-5:00 P.M.
Meeting Room H

10. Glasses as Electrolytes in Galvanic Cells. *By G. E. Rindone and W. A. Weyl, Pennsylvania State College, State College, Pa.*

The behavior of glass as an electrolyte in galvanic cells has been used as a means to study the constitution of glass. Potentials have been measured in cells made of alkali borate, silicate, and phosphate glasses containing heavy metal ions. The magnitude of the potentials is indicative of the forces between these heavy metal ions and the glass. Platinum electrodes were used. For Ag + glasses, cells of the type Pt/Ag + Glass/Ag/Pt were formed by reduction of the Ag + ions in the vicinity of one electrode by hydrogen at 200° to 400°C. The silver in the vicinity of this electrode behaved as a silver electrode. The e.m.f. of these cells was in the order of 1.0 volt for silicate glasses, 0.7 volt for borate glasses, and 0.3 volt for phosphate glasses. The interpretation of these potentials is based on the stability

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• O. B. Wilson, eastern regional sales manager for Brown Instruments Division of Minneapolis-Honeywell Regulator Company, has been named Manager of Sales for the east, southeast and central regions.

REFRACTORIES FOR GLASS FURNACES . . .

(*Continued from page* 234)

quate regenerator space, which however may not always be feasible, the refractories are favored, and the commonly used open-checker setting usually performs satisfactorily.

The basket-weave arrangement is preferred in many cases, especially where the checkers are necessarily subjected to very severe conditions. This design provides full bearing for all the checkers.

THATCHER'S MEN'S CLUB . . .

(*Continued from page* 226)

foreman, now let's take a look and see what the worker expects the foreman to do. The worker expects the foreman to: 1. Keep the workers busy without driving them. Idle time breeds discontent; 2. Know the capabilities of each one and judge him honestly; 3. Teach them how to do the job correctly, thoroughly and without any omission; 4. Maintain discipline; 5. Insist upon safety; 6. Be willing to discuss individual grievances fairly; 7. Insist upon production standards; 8. Be a good workman as well as a good foreman; 9. Be friendly and have the respect of other foremen; 10. Know his job thoroughly.

AMERICAN OPTICAL COMPANY STAFFS RESEARCH LABORATORY

The American Optical Company has announced the addition of Dr. Charles J. Burton and Dr. Walter A. Fraser to the staff of its recently established research laboratory in Stamford, Conn.

Dr. Burton, a graduate of Colgate and New York Universities, has been employed in the research laboratories of American Cyanamid Company for the past eleven years as group leader in charge of the electrophysics section. He is the author of numerous scientific papers and a member of the American Physical Society, American Chemical Society and the Electron Microscope Society of America.

Dr. Fraser, a graduate of Iowa State College, has been employed by the Perkin-Elmer Corporation in production and research capacities for the past several years. Prior to that, he was associated with Bausch & Lomb Optical Company doing glass research.

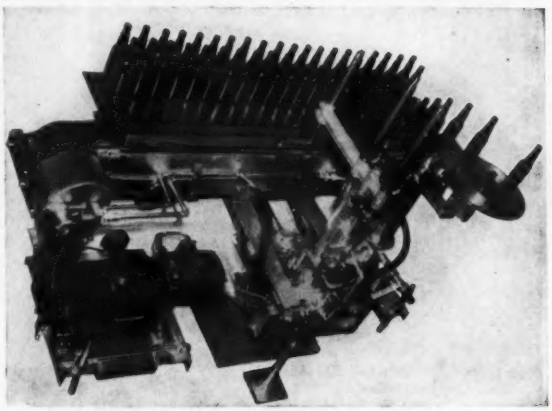
The laboratory staff at American Optical Company will carry on research in fields related to the optical sciences and to scientific instruments, as well as research bearing directly on the company's products and processes. Among the projects contemplated are basic studies in physiological optics, glass chemistry, optical instrumentation, plastics as optical components, spectroscopy and microscopy.

• Robert E. Rielly has joined Chas. Taylor Sons Company as Assistant to Robert W. Knauft, Vice President in charge of Sales. Mr. Rielly will assist in the supervision of the company's national advertising program, as well as perform sales duties.

The

UNIVERSAL LOADER

an inexpensive machine for higher lehr loading efficiency



GLAPAT CORPORATION
Zanesville, Ohio

Eliminate
Hand Polishing of GLASS MOLDS

ELIMINATE expensive hand-cleaning and polishing of glass molds with Pangborn *Hydro-Finish!* Cleans molds faster than other methods yet holds tolerances. Maintains sharp edges and contours . . . leaves mold bright, ready-for-use.

Complicated molds or designs are easily cleaned *throughout* because Hydro-Finish uses fine-mesh abrasives suspended in water, impelled through controlled feed. By holding tolerances to *.0001* Pangborn Hydro-Finish substantially increases life of molds.

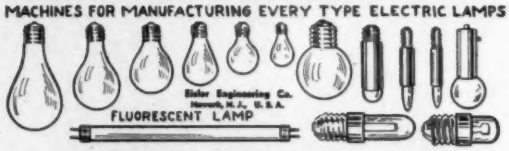
FREE: **WRITE OR WIRE TODAY FOR BULLETIN 1400**
Address: Pangborn Corp., 1211 Pangborn Blvd., Hagerstown, Maryland.

Pangborn
BLAST CLEANS CHEAPER
with the right equipment for every job

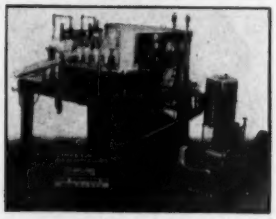
AUTOMATIC EISLER AUTOMATIC
GLASS MACHINERY AND GLASS FORMING UNITS

FOR THE COMPLETE MANUFACTURE OF COLD OR HOT CATHODE LAMPS, INCANDESCENT AND FLUORESCENT LAMPS, RADIO — ELECTRONIC — NEON SIGN — TELEVISION TUBES, VACUUM FLASKS, EYE DROPPERS, etc.

SEALING MACHINES — STEM MAKING MACHINES
MACHINES FOR MANUFACTURING EVERY TYPE ELECTRIC LAMPS

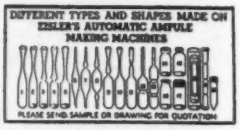


BULB BLOWING MACHINES — AMPULE MACHINES



36 HEAD AUTOMATIC EXHAUST MACHINE

Burners for All Types of Glasswork. Crossfires, Tipping Torches, Pyrex Glass Fires, Oxygen and Hydrogen Fires.


DIFFERENT TYPES AND SHAPES MADE ON EISLER'S AUTOMATIC AMPULE MAKING MACHINES
PLEASE SEND SAMPLE OR DRAWING FOR QUOTATION

CROSS FIRES

CHAS. EISLER

WE INVITE YOUR INQUIRIES

EISLER ENGINEERING CO., INC.
742 SOUTH 13TH STREET (near Avon Ave.) NEWARK 3, N. J., U.S.A.

BORAX and BORIC ACID
99½-100% Pure

POTASSIUM NITRATE
CAUSTIC SODA
SULPHUR

Stauffer CHEMICALS
SINCE 1885

STAUFFER CHEMICAL CO.
420 Lexington Avenue, New York 17, N. Y. — 525 South Flower Street, Los Angeles 13, Cal.
221 North LaSalle Street, Chicago 1, Illinois — 636 California Street, San Francisco 8, Cal.
Portland, Oregon — Houston 2, Texas

GLASS USED FOR CONVERTIBLE TOPS

A cloth, known as Cordoglas, woven of strong, rot-proof Fiberglas yarns and coated with a pigmented Vinylite resin to provide a range of colors is being used to install convertible tops for 1949 automobile models.

The glass fabric was designed to give the convertible owner a top that would stand up under all climatic conditions and would retain its color and general good appearance throughout its long life. The glass fabric provides a quiet top for it will not stretch, shrink or sag so there is no ballooning or snapping. The top won't fade, rot or mildew. The fabric can be cut and sewed with the equipment now used for other top fabrics.

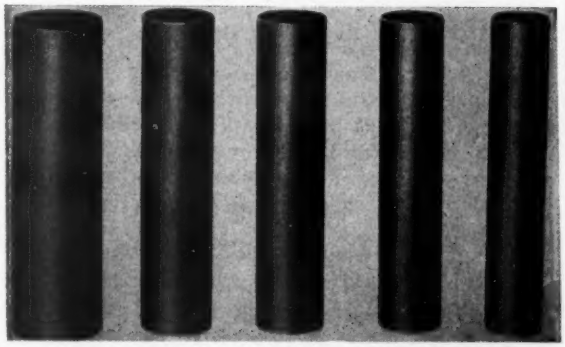
TENNESSEE VALLEY SECTION OF A.C.S. HOLDS SECOND MEETING

The second meeting of the newly formed Tennessee Valley Section of the American Ceramic Society was held recently with over 125 persons in attendance.

Charles Pearce, General Secretary of the Society, was present at the meeting. Following Mr. Pearce's talk, several technical talks were presented.

• Research and development of safety equipment for all industries will be undertaken in a new laboratory to be built in Pittsburgh by Mine Safety Appliances Company. Construction of a four-story laboratory building is expected to be completed in September. Facilities of the laboratory will be made available to all industry for the investigation of safety equipment problems affecting health and property.

GUNITE



ROUND BAR STOCK

Gunite can be machined with relative ease, yet has a high density that will take a brilliant polish. Round Bar Stock is available in 18 sizes from ¾" to 5" diameter, all bars 14" long. There is a suitable Gunite alloy for many types of glass-making castings such as Plungers, Ring Sticks, Neck Rings, Guide Rings, Moulds, Blanks, Bottom Plates, etc.

MADE BY GUNITE FOUNDRIES ROCKFORD, ILLINOIS

CLASSIFIED ADVERTISEMENTS

FOR SALE

PYROMETERS—POTENTIOMETERS—Brown, Foxboro, Leeds & Northrup. Indicating & Recording, 1600° to 3000°F., $150.00 each; Indicating 0 to 1600°F. & 3000°F., $75.00 each; Partly 110 V, Partly 220 V. Several instruments of each kind. Rotary Multiple switches 12 points with off (Brown) $20.00 each. All in working order. Available due to changed control methods. Thatcher Glass Manufacturing Company, Inc., Box 265, Elmira, New York.

200 ton clean, lime glass, tableware cullet for sale. $15.00 per ton, f.o.b. Dunbar, West Virginia. Analysis on request. Dunbar Glass Corporation, Dunbar, West Virginia.

HELP WANTED

SUPERINTENDENT for foreign fourcault window glass plant. Must be thoroughly familiar with furnace and machine operation. Arthur W. Schmid Co., 520 Investment Building, Pittsburgh, Pa.

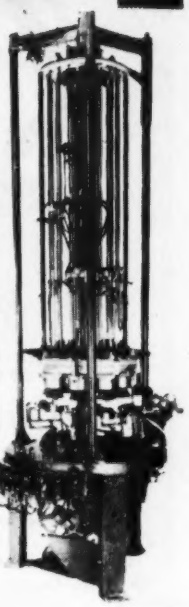
CAMBRIDGE WIRE CLOTH HOLDS ANNUAL SALES MEETING

The Cambridge Wire Cloth Company recently held its Annual Sales Meeting at the company's home office in Cambridge, Maryland. The meeting was attended by Cambridge representatives from the entire nation.

The week's sessions were highlighted by discussions of product application in the many fields in which Cambridge products are used.

Kahle

AMPULE BLOWING MACHINERY



is specifically designed to meet your particular needs

Kahle machinery is *not* stock machinery! Every piece of Kahle equipment is specifically designed to accomplish a specific purpose. The Automatic Ampule Blowing Machine shown here illustrates the experience and ingenuity we can place at your disposal to help solve *your* ampule and bulb blowing problems.

TELL US YOUR REQUIREMENTS

Your inquiries will receive prompt attention. Our catalog is available upon request.

AUTOMATIC AMPULE BLOWING MACHINE

Will blow up to 2½" o.d. by 7¼" overall length, including stem or constricted neck. Speeds up to 2400 per hr.

We specialize in equipment and methods for the manufacture of:

- Radio Tubes
- Cathode Ray Tubes
- Fluorescent Lamps
- Incandescent Lamps
- Neon Tubes
- Photo Cells
- X-Ray Tubes
- Glass Products

Kahle ENGINEERING COMPANY

1313-15 Seventh Street
North Bergen, New Jersey, U.S.A.

APLITE

APLITE IS A LOW COST SOURCE OF ALUMINA FOR USE IN PRODUCTION OF GLASS PRODUCTS

Your Inquiries and Orders Are Solicited

DOMINION MINERALS Incorporated
Telephone 2411
PINEY RIVER, VIRGINIA
Pioneer producers of high grade aplite

Our Moulds Don't Cost--They Pay

An Order a Day Will Keep Overmyer Away

OVERMYER MOULD COMPANY
Factories at
GREENSBURG, PENNSYLVANIA
SOUTHGATE, CALIFORNIA
WINCHESTER, INDIANA

OMCO SCREW MACHINE PRODUCTS
SPRINGFIELD, OHIO

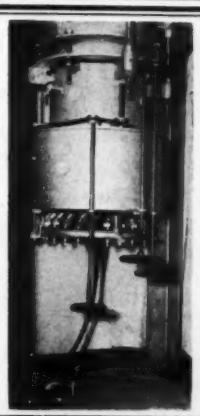
"THE NEW DANNER MACHINE for GLASS TUBING & ROD"

Economical to own and maintain, simple in construction and operation. Unusual flexibility in both forming and drawing equipment, permitting quick changes to meet production needs. Marked advancement as compared to the original Danner machine.

THE FORMING EQUIPMENT is designed so that with minor changes it can be applied to either a continuous tank for quantity requirements or to a day tank for small requirements with intermittent operation, and frequent changes in color or formula.

THE DRAWING & SEVERING EQUIPMENT is suitable for a wide range of sizes and cut lengths. These lengths may be varied by 1" & 2" steps from 52" to 200" by making minor changes.

NEW TYPE SHAPING ELEMENT which unites two or more glass streams at the ware forming plane. This construction provides for greatly increased drawing speeds on the various wall thickness and tube diameters. Small tubing can be drawn in excess of 1000 ft. per minute.



DANNER SPECIAL GLASS MACHINERY
Mt. Vernon Road, Newark, Ohio